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PROCEEDINGS

OF THE

Biological Society of Washington

VOLUME IX
1894–1895

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1894–'95.

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LIST OF THE OFFICERS AND COUNCIL

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

FOR 1894

(ELECTED DECEMBER 30, 1893)

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* Ex-Presidents of the Society.

LIST OF THE OFFICERS AND COUNCIL

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

FOR 1895

(ELECTED DECEMBER 29, 1894)

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F. A. Lucas
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Committee on Publications

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* Ex-Presidents of the Society.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

PROCEEDINGS.

January 13, 1894—220th Meeting.

The President in the chair and twenty-three persons present.

The following communications were presented:

R. T. Hill: A New Fauna from the Cretaceous Formation of Texas.*

Ch. Wardell Stiles: The Teaching of Biology in Colleges.

January 27, 1894—221st Meeting.

The President in the chair and twenty-two persons present.

The following communications were presented:

J. N. Rose: A Botanical Trip to Northwestern Wyoming.

B. T. Galloway: A Rust of Pine Leaves and the Effect of the Parasite on the Host.

Theodore Gill: The Segregation of the Osteophysial Fishes as Fresh Water Forms.†

February 10, 1894—222d Meeting.

The President in the chair and twenty-three persons present.

The following communications were presented:

M. B. Waite: The Treatment of Pear Leaf-Blight.‡

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* Abstract in Am. Journ. Sci., 3d ser., xlvii, 141, Feb., 1894.

† The Early Segregation of Fresh Water Fishes. <Science, NS., I., 678-679, Nov. 22, 1895.

‡ Abstract in Science, March 15, 1895, 305-306. Full paper: Treatment of Pear Leaf-Blight (*Entomosporium maculatum*) in the Orchard. <Journal of Mycology, vii, No. 4, 333-338, pls. xxxii and xxiii, Aug. 15, 1894.

C. Hart Merriam: A Remarkable New Rabbit from Mexico.

Ch. Wardell Stiles: *Distoma westermanni* in the Lungs of a Cat.*

C. V. Riley: The Transmission of Acquired Characters.

February 24, 1894—223d Meeting.

Vice-President B. E. Fernow in the chair and fifteen persons present.

The following communications were presented:

M. B. Waite: The Structure and Method of Opening of the Anthers of the Pomeæ.

B. T. Galloway: The Winter Coloration of Evergreen Leaves.

L. O. Howard: Notes on Spider Bites.

March 10, 1894—224th Meeting.

Ex-President Lester F. Ward in the chair and twenty persons present.

C. H. Townsend: The Ornithology of Cocos Island in its Relation to that of the Galapagos Archipelago.†

B. T. Galloway: A Hexenbesen of *Rubus.*

M. B. Waite: The Hexenbesens of Washington and Vicinity.

Wm. Palmer: Rare Birds taken in the District of Columbia.

Leonhard Stejneger exhibited a specimen of a spade-foot toad (*Spea*) found in sandstone 23 feet below the surface.

March 24, 1894—225th Meeting.

Vice-President Richard Rathbun in the chair and twenty persons present.

The following communications were presented:

Theobald Smith: On the Significance of Variation among Species of Pathogenic Bacteria.

Vernon Bailey: On Some Bones from a Cave in Arizona.

---

* Notes on Parasites, 26: *Distoma* (*Mesogonimus*) *westermanni.* Discovery of a parasite of Man, new to the United States. <Johns Hopkins Hospital Bulletin, No. 40, 57–58, figs. 1–4, 1894.

† Birds from Cocos and Malpelo Islands, with notes on Petrels obtained at Sea. <Bull. Mus. Comp. Zoöl., xxvii, No. 3, 121–126, 2 col. pls., July, 1895.

C. D. Walcott: On Some Appendages of the Trilobites.* and On the Occurrence of Fossil Medusæ in the Middle Cambrian Terrane.

April 7, 1894—226 Meeting.

Vice-President Frank Baker in the chair and twenty-five persons present.

Discussion: What is a Living Cell?

April 21, 1894—227th Meeting.

The President in the chair and twenty persons present.

The following communications were presented:

B. T. Galloway: The Effect of Spraying with Fungicides on the Growth of Nursery Stock.†

A. F. Woods: The Calorific Effect of Light upon Plants.

Erwin F. Smith: The Length of Vessels in Higher Plants.‡

Ch. Wardell Stiles: Adult Cestodes of Herbivorous Animals.

May 5, 1894—228th Meeting.

The President in the chair and seventeen persons present.

The following communications were presented:

Lester F. Ward: A Recent Collection of Fossil Cycads from the Potomac Formation of Maryland.§

B. T. Galloway: The Size and Weight of Seed in Relation to the Size and Weight of the Plant.||

May 19, 1894—229th Meeting.

The President in the chair and twenty-three persons present.

The following communications were presented:

C. Hart Merriam: The Dental Armature of Pocket Gophers (*Geomys*).¶

---

* Note on some Appendages of the Trilobites. <Proc. Biol. Soc. Wash., vol. ix, 89–97, pl. 1, March 30, 1894.

† Bull No. 7, Div. Veg. Path., U. S. Dept. Agric., Aug., 1894.

‡ Science, NS., I., 77, 1895.

§ Bull. Torrey Bot. Club, xxi, No. 7, 291–299, July 20, 1894.

|| Agricultural Science, vol. 8, 557, 1894.

¶ Monographic Revision of the Pocket Gophers, family Geomyidæ, chap. iii. The Dental Armature. <N. Am. Fauna, No. 8, 69–97, figs. Jan. 31, 1895.

William Palmer: The Nesting Sites of the Blue Gray Gnat-Catcher.

H. J. Webber: The Dissemination of the *Yucca.*

October 20, 1894—230th Meeting.

Ex-President Wm. H. Dall in the chair and fifteen persons present.

The following communications were presented:

A. F. Woods: Some Effects of Spraying Mixtures on the Growth of Plants.*

Ch. Wardell Stiles: Experimental Trichinosis in a New Host.†

Short notes by several members.

November 3, 1894—231st Meeting.

The President in the chair and sixteen persons present.

The following communications were presented:

Theodore Gill: A Remarkable New Bassalian Family of Crabs.‡

Charles T. Simpson: The Geographical Distribution of Land Shells in Jamaica.

M. A. Carleton: Notes on Artificial Infection with Uredospores.

November 17, 1894—232d Meeting.

The President in the chair and fifteen persons present.

The following communications were presented:

Charles L. Pollard: The Genus *Cassia* in America.

Short notes and exhibitions of specimens by various members.

December 1, 1894—233d Meeting.

The President in the chair and thirty-four persons present.

The following communications were presented:

B. T. Galloway: The Physiological Significance of Transpiration of Plants.

---

* Proc. Amer. Ass. for the Adv. of Agrl. Science for 1895 (in press).

† Notes on Parasites, 27: Experimental trichinosis in *Spermophilus 13-lineatus.* <Centralblatt f. Bakt. u. Parasitenkunde, xvi, No. 19, 777–778, 1894. Idem. <The Veterinary Magazine, i, No. 11 (for Nov., 1894), 727–728, Jan., 1895.

‡ A new Bassalian type of Crabs. <Am. Nat., vol. 28, 1043–1045, Dec., 1894.

F. H. Knowlton: The Amount of Water Transpired by Plants.

B. W. Evermann: On the Red Fish of the Idaho Lakes.

December 15, 1894—234th Meeting.

The President in the chair and eighteen persons present.

The following communications were presented:

Charles T. Simpson: The Validity of the Genus *Margaritana*.[*]

C. V. Riley: Some Interesting Results of Injuries to Trees.

Erwin F. Smith: The Last Phase of the Root Tubercle Question.[†]

December 29, 1894—235th Meeting.

(Fifteenth Annual Meeting.)

The President in the chair and fifteen persons present.

The annual reports of the Secretary and Treasurer were presented, and officers for 1895 were elected as follows:

President: Surgeon General George M. Sternberg.

Vice-Presidents: Richard Rathbun, C. D. Walcott, B. E. Fernow, L. O. Howard.

Recording Secretary: M. B. Waite.

Corresponding Secretary: F. A. Lucas.

Treasurer: F. H. Knowlton.

Additional Members of the Council: Wm. H. Ashmead, Tarleton H. Bean, Theobald Smith, Ch. Wardell Stiles, F. W. True.

January 12, 1895—236th Meeting.

The President in the chair and fifty-three persons present.

The evening was devoted to a lecture by

L. H. Bailey: The Plant Individual in the Light of Evolution.[‡]

January 26, 1895—237th Meeting.

The President in the chair and fifteen persons present.

The following communications were presented:

L. O. Howard: A New Cotton Enemy brought over from Mexico.

---

[*] Am. Nat., vol. 29, 336–344, April, 1895.

[†] Am. Nat., vol. 29, 898–903, Oct., 1895.

[‡] The Plant Individual in the Light of Evolution. <Science, NS., I., 281–292, March 15, 1895.

Theodor Holm: Anatomy of a Leaf-Gall of *Pinus virginiana.*

Lester F. Ward: The Mesozoic Flora of Portugal compared with that of the United States.*

February 9, 1895—238th Meeting.

The President in the chair and thirty persons present.

The following communications were presented:

George M. Sternberg: Explanation of Immunity from Infectious Diseases.†

Theodore Gill: *Pithecanthropus.*‡

February 23, 1895—239th Meeting.

Vice-President B. E. Fernow in the chair and twenty-two persons present.

The following communications were presented:

F. E. L. Beal: The Food Habits of Woodpeckers.§

F. A. Lucas: Some Abnormal Feet of Mammals. ||

M. B. Waite: Notes on the Flora of Washington, D. C., and Vicinity.¶

March 9, 1895—240th Meeting.

The President in the chair and thirty-two persons present.

The following communications were presented:

Ch. Wardell Stiles: A Double-pored Cestode with Occasional Single Pores.**

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*Science, NS., I., 337–346, March 29, 1895.

†Science, NS., I, No. 13, 346–349, March 29, 1895; also incorporated in Part First (Susceptibility and Protective Inoculations) of work entitled *Immunity, Protective Inoculations, and Germ-Therapy*, by Surgeon General George M. Sternberg, U. S. A., 1895.

‡The Nation, lx, 105, Feb. 7, 1895.

§ Abstract in Science, March 15, 1895, 304–305; published in full in Preliminary Report on the Food of Woodpeckers, Bull. 7, Division of Ornithology and Mammology, U. S. Dept. Agric., pp. 1–33, August, 1895.

|| Abstract in Science, March 15, 1895, 305.

¶ Ibid., 305-306.

** Notes on Parasites, 36: A double-pored cestode with occasional single pores. <Centralblatt f. Bakt. u. Paras., 1 Abth., Bd. xvii, No. 13–14, 457–459, 1 fig., 1895. (Abstract in Science, March 22, 1895, 334.)

Theodor Holm: The Œdema of Violet Leaves.*

George M. Sternberg: Explanation of Acquired Immunity.†

March 23, 1895—241st Meeting.

The President in the chair and twenty-six persons present.

The following communications were presented:

Charles T. Simpson: The Respective Value of the Shell and Soft Parts in Naiad Classification.‡

F. V. Coville: Remarks on the New Botanical Check List.§

Joseph F. James: Remarks on *Daimonelix* and Allied Fossils.||

Ch. Wardell Stiles: On the Presence of Adult Cestodes in Hogs.¶

April 6, 1895—242d Meeting.

Vice-President L. O. Howard in the chair.

The following communications were presented:

Theodore Gill: On the Torpedoes.**

J. W. Powell: The Classification of the Subject-Matter of Biology.

April 20, 1895—243d Meeting.

Vice-President L. O. Howard in the chair and twenty-nine persons present.

The following communications were presented:

Frank Baker: Some Peculiarities of Lumbar Vertebræ.

Theobald Smith: On Infectious Entero-Hepatitis of Fowls due to Protozoa.††

---

* Abstract in Science, March 22, 1895, 334.

† Science, NS., I, No. 13, 346–349, March 29, 1895; also included in *Immunity, Protective Inoculations and Germ-Therapy*, by Surgeon General George M. Sternberg, U. S. A., 1895.

‡ Abstract in Science, April 12, 1895, 418–419.

§ Ibid., 419.

|| Ibid., 420.

¶ Notes on Parasites, 34: On the Presence of adult Cestodes in Hogs. <Veterinary Magazine, II, 220–222, 1895. Idem. <Centralbl. f. Bakt. u. Parasitenkunde, xvii, No. 7–8, 256–257, 1895.

** Abstract in Science, May 3, 1895, 502–503.

†† An Infectious Disease among Turkeys caused by Protozoa (Infectious Entero-Hepatitis). Bull. No. 8, Bureau of Animal Industry, U. S. Dept. Agric., October, 1895. (Abstract in Science, May 10, 1895, 531.)

G. Brown Goode: The Horizontal and Vertical Distribution of Deep Sea Fishes.*

May 4, 1895—244th Meeting.

Vice-President B. E. Fernow in the chair and forty-two persons present.

The following communications were presented:

Charles T. Simpson: The Geographical Distribution of Fresh-Water Mussels.†

Erwin F. Smith: The Other Side of the Nomenclature Question.‡

May 18, 1895—245th Meeting.

The President in the chair and twenty-eight persons present.

The following communications were presented:

C. Hart Merriam: The Mammals of the Pribilof Islands.§

Edgar A. Mearns: The Hares (Genus *Lepus*) of the Mexican Border.||

Erwin F. Smith: The Biology of *Bacillus tracheiphilus.*¶

Ernest E. Thompson: The Means of Intercommunication among Wolves.

June 1, 1895—246th Meeting.

The President in the chair and seventeen persons present.

The following communications were presented:

C. Hart Merriam: The Short-tailed Shrews of America.**

G. Brown Goode: On the Location and Record of Natural Phenomena by a Method of Reference to Geographical Coördinates.

Theodore Gill: On the Relation of the Ancient and Modern Ceratodontidæ.††

---

* Abstract in Science, May 10, 1895, 531–532.

† Abstract in Science, May 24, 1895, 586–587.

‡ The Botanical Club Check List: A Protest (privately printed). Abstract in Science, May 24, 1895, 587–588.

§ Abstract in Science, June 21, 1895, 698.

|| Ibid., 698–699.

¶ Centralb. f. Bakt. u. Parasitenkunde, Allg. vol. I, 364–373, 1895.

** Revision of the Shrews of the American Genera *Blarina* and *Notiosorex.* <North Am. Fauna, No. 10, 5–34, pls. 1–3, Dec. 31, 1895.

†† Science, NS., I, June 28, 1895, 725.

Lester F. Ward: Remarks on the Genus *Caulinites* Brongn., with exhibition of specimens.*

October 19, 1895—247th Meeting.

The President in the chair and twenty-six persons present.

The following communications were presented:

S. D. Judd: The Food of the Catbird, Brown Thrasher, and Wrens.

L. O. Howard: An Enemy of the Hellgramite Fly.†

W. H. Dall: Exhibition of Remains of the Mammoth. ‡

Ch. Wardell Stiles: The Rudolph Leuckhart Memorial § and The Third International Zoölogical Congress.

C. Hart Merriam: North American Shrews. ||

November 2, 1895—248th Meeting.

The President in the chair and twenty-four persons present.

The following communications were presented:

F. V. Coville: The Botanical Explorations of Thomas Coulter in Mexico and California.¶

William Palmer: Albinistic Birds' Feet.

F. A. Lucas: The Extinct Gigantic Birds of Patagonia.**

Theodore Gill: The Belone and Sarginas of Aristotle.††

November 16, 1895—249th Meeting.

The President in the chair and thirty-three persons present.

The following communications were presented:

B. W. Evermann: The Fishes of the Missouri River Basin. ‡‡

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*Science, NS., I, June 28, 1895, 725–726.

† Abstract in Science, Nov. 8, 1895, 635.

‡ Ibid., 635–636.

§ The Rudolph Leuckhart Memorial. <Science, NS., II, 1895, 523–524.

|| Synopsis of the American Shrews of the genus *Sorex*. <North Am. Fauna, No. 10, 57–98, pls. vii–xii, Dec. 31, 1895.

¶ Botanical Gazette, xx, 519–531, pl. xxxv, Dec., 1895. Abstract in Science, Nov. 22, 1895, 702–703.

** Abstract in Science, Nov. 22, 1895, 703. The Auk, xiii, Jan., 1896, 61–63.

†† Science, NS., II, 703, Nov. 22, 1895.

‡‡ Abstract in Science, Dec. 6, 1895, 778. Full paper in press in Rept. Com. of Fish and Fisheries for 1894.

Frank Baker: The Nomenclature of Nerve Cells.*

Edward L. Greene: Some Fundamentals of Nomenclature. †

November 30, 1895—250th Meeting.

The President in the chair and thirty-five persons present.

The following communications were presented:

Edward L. Greene: Some Fundamentals of Nomenclature (continued).‡

Theodor Holm: Contributions to the Flora of the District of Columbia.§

December 14, 1895—251st Meeting.

Hon. Gardiner G. Hubbard, President of Joint Commission, in the chair.||

Annual address of the President, Surgeon General George M Sternberg: The Practical Results of Bacteriological Researches.¶

December 27, 1895—252d Meeting.

(Sixteenth Annual Meeting.)

The President in the chair and nineteen persons present.

The annual reports of the Secretary and Treasurer for the year 1895 were presented, and officers for the year 1896 were elected as follows:

President: Surgeon General George M. Sternberg.

Vice-Presidents: Richard Rathbun, C. D. Walcott, B. E. Fernow, L. O. Howard.

Recording Secretary: M. B. Waite.

Corresponding Secretary: F. A. Lucas.

Treasurer: F. H. Knowlton.

Additional Members of the Council: William H. Ashmead, F. V. Coville, C. S. Pollard, Ch. Wardell Stiles, F. W. True.

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*Abstract in Science, Dec. 6, 1895, 778.

† Science, NS., III, 1, 13–16, Jan. 3, 1896.

‡ Science, NS., III, 1, 13–16, Jan. 3, 1896.

§ Abstract in Science, Jan. 3, 1896, 34–35. To be published in full in next volume Proc. Biol. Soc. Wash.

|| Public meeting in Builders' Exchange Hall under the auspices of the Joint Commission, followed by informal reception, with refreshments. Several hundred people present.

¶ To be published in Popular Science Monthly.

Vol. IX, pp. 1-74 April, 1894

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

SOCIAL INSECTS FROM PSYCHICAL AND EVOLUTIONAL POINTS OF VIEW.*

BY C. V. RILEY, PH. D.

Prelude.

Friends and Fellow-members:

Custom has ordained that the president of the Biological Society deliver an annual address, and that the public be invited to listen thereto. This custom, likewise followed by some of our sister societies, has certain advantages, but also certain disadvantages. Instead of appealing to members only, or treating, in special and technical way, some subject that intimately concerns them, the speaker finds it incumbent upon him to popularize his subject, and to endeavor to interest alike those who are and those who are not familiar with the science of biology in any of its special branches. It will be my endeavor to accomplish this dual task to-night by omitting the reading of the more technical and detailed portions of this paper, which, though in one sense the most important, may well be printed in smaller type, as a series of notes.

My predecessors have generally dealt with the subjects upon which they were working as specialists, or upon which they were known to be authorities. In following this precedent, I am not unmindful of the fact that the science of entomology in its more abstruse and technical phases, however fascinating to the specialist, attracts but little public attention, and that, from among the myriad forms of life which the entomologist includes within the scope of his study, there are comparatively few which interest the intelligent masses or even the general biologist. Among these few are the social insects, and it is my purpose to treat of them to-night and see what light we may draw from them on some of the great questions which now agitate naturalists. By combining the recorded observations and views of others with some that are original and unpublished, I may, perhaps, hope to interest all of you.

---

*Annual address of the President of the Society, delivered in the hall of Columbian University, January 29, 1894. The address was illustrated with stereopticon views, only a few of which are here reproduced.

Before entering on this main topic, however, it has seemed to me advisable, in view of the character of the audience, to say something of our society and what it undertakes to do. Biology is a word of the century, and was first employed by Lamarck (1801) as a term under which the phenomena of organic nature could be considered; and by Treviranus (1802) to express the science that treats of the philosophy of living nature. Systematic zoology and botany have but incidental bearing on biology; they relate to the framework, the structure, and not to life itself. Not that I undervalue taxonomy in this connection, for, indeed, its value is self-evident; but modern biologists are very generally divided into two camps, viz., those who investigate the different parts and structures of the organism, or who study the processes of growth, and those who study more particularly that phase of the subject which Hæckel called œcology. In the process of differentiation the term is now, perhaps, more correctly applied to the study of the development of the type in the past, and of the individual in the present—not by themselves only, but in their relations to all other forms of life. In other words, it involves the interactions and interrelations of organisms, and deals fundamentally with psychical even more than with structural phenomena, as naturalists use these terms.

The Biological Society was organized for the purpose of considering and discussing the questions involved in the very broadest application of the term biology; in others words, organic nature in any and all of her manifestations. Organized but about two years prior to the death of Charles Darwin, it is not surprising that its members have been very generally imbued with the spirit and interpretations which the illustrious author of "The Origin of Species" gave to the phenomena of life upon our planet. Not that they have been blind followers of the school which believes in the all-sufficiency of natural selection to account for life-phenomena; for a review of the communications and discussions and particularly of the addresses which have been delivered by my predecessors will show that in the search after truth, the ideas of Lamarck and others, who have pregnantly speculated on the philosophy of life, have been duly appreciated. Upon the one great question which, more than any other, has occupied biologists of late years, viz., whether functionally acquired characters are transmitted by heredity, there have been few more able contributions to the subject anywhere published than the papers and addresses of my distinguished predecessor, Prof. Lester F. Ward. Indeed, aside from the reasons already given, the choice of my subject to-night was in no small degree determined by an admission in one of his more recent and yet unpublished communications to the society, to the effect that the characters of neuters among the social insects offer the greatest stumbling block to the theory of the heredity of such acquired characters.

ORGANIZED INSECT SOCIETIES.

The social insects, or those which live in communities, and particularly those of the order Hymenoptera, which possess highly developed social characteristics, have, from the very earliest times, intensely interested the student of insect life. There are insects of other orders which are either social normally or become so by exception and for special purposes. Thus many Lepidopterous larvæ live together when young, but scatter when they grow older. In some cases there would seem to be no particular purpose in the association; in others, as in the common Tent Caterpillars (Clisiocampa spp.) the well-known Fall Webworm of North America (*Hyphantria cunea*) and many similar species of other countries, the association is of a somewhat higher character, as the larvæ build a common web into which they retire at stated periods, and which helps to protect them both from the inclemencies of the weather and from the attacks of birds and other enemies. The highest development of this social trait in the Lepidoptera is found in the small Hyponomeutidae, and in a Mexican butterfly (*Eucheira socialis* Westw.)—the transformations taking place within the nest. The layers of silk in the last-named species are so tough that they have been used as parchment.

In one remarkable case among the Diptera, viz., in Sciara, a genus of small gnats, the larvæ have the habit of banding together in large masses, more or less elongate, all the individuals attached to each other, heads to tails, and the whole mass moving with one impulse and as a unit. They thus move across a road or field, like some huge snake, and are for that reason called "snake-worms," and really give us a very good illustration of how individual units may combine to make a compound whole. Many other insects have the exceptional habit of congregating together in large masses, but in almost every case the congregating is connected with undue multiplication and the desire to migrate to new regions. The habit is well exemplified in our notorious Army Worm, the larvæ of *Leucania unipuncta*, an insect which, over vast stretches of country, occasions great loss to our grain and grass crops by traveling from field to field and leaving devastation in its wake. Instances of this kind might be multiplied; but we do not apply the term social to such temporary associations of individuals, even where they have any specific purpose and are of annual recurrence. Nor do we apply the term social to those insects, of which there are many in different orders, which assemble together during the love or pairing season. The term is strictly confined to those species which permanently live together in colonies, and in which the social habit, with its consequent subdivision of labor, and differentiation of individuals, has become essential to their perpetuity.

BEES.

Living in such well organized communities, exhibiting so much intelligence, and yielding one of the most delicious sweets known, the Honey or Hive Bee has attracted attention from the earliest times, and ever since Aristotle, Virgil and Columella told what was then known of this industrious insect, it has been the subject of investigation. Honey and wax were far more important to man in olden time than they are to us who have so many substitutes for them, and the ancients gave much attention of the practical kind to bees. How very little they knew, however, of their true economy is shown by the prevalence of the belief that bees came from the carcasses of animals. This superstition as to the *Bugonia*, as exemplified in the biblical story of Samson (Judges XIV, 8) continued for twenty centuries and grew out of the resemblance to the Hive bee of *Eristalis tenax*, a Dipterous fly which breeds in putrescent matter. This fact, first clearly recognized by that excellent observer, Réaumur, has been fully established in a recent most interesting paper by Osten Sacken "On the so-called *Bugonia* of the ancients, and its relations to *Eristalis tenax*." (Bullettino della Società Entomologica Italiana, Anno XXV, 1893). In fact the fabulous about bees prevailed till the beginning of the last century, when Maraldi, by the invention of glass hives, gave an impetus to correct observation, and led to the remarkable memoirs of Swammerdam, Réaumur, Schirach and Francis Huber.

The fact that the Hive Bee can be cultivated and controlled with a view to profitable industry, has served to heighten the interest in it, and since the invention in this country, in 1852, of the movable frame hive, by a retired clergyman, the Rev. L. L. Langstroth, progress in apiculture has been rapid and continuous. Of the more important subsequent inventions, many of them made in Europe but perfected in America, may be mentioned the honey-extractor, which, by centrifugal force, throws the honey from the comb, leaving the latter intact and ready to be used again; and the comb foundation, by which sheets of wax are impressed with the bases of the cells and employed to ensure straight and regular combs, to limit drone production and increase the honey product. With the bee-smoker in its modern form, bees are also much more easily controlled and manipulated than formerly. Much has been done, also, in ameliorating the races of bees, both by introducing races from other countries and by the crossing of these. There are some three hundred thousand of our citizens engaged in bee culture, and they add over twenty million dollars annually to the wealth of the country in honey and wax. This amount may be, and in the near future doubtless will be, very largely increased. It is, in fact, difficult to realize what an immense amount of honey is wasted from lack of bees to garner it, and the poet Gray would seem to have had his own ideas on this subject when he wrote the familiar lines.

"Full many a flower is born to blush unseen,
And waste its sweetness on the desert air."

The service directly rendered to man by bees, however, in supplying the products mentioned, is but slight as compared with the services indirectly rendered by cross-fertilization of our cultivated plants, and it has been estimated that the annual addition to our wealth by bees in this direction alone, far exceeds that derived from honey and wax. One of the latest discoveries bearing on this subject, very fully enforcing the general principle, was presented to the Society for the first time within the past year by our fellow-member, Mr. M. B. Waite, as a result of his investigations for the Division of Vegetable Pathology in the Department of Agriculture. He has proved that a majority of the more valued varieties of our apples and pears are nearly or wholly sterile when fertilized by pollen of the same variety, or that they bear fruit of an inferior character and very different from that produced when cross-fertilized; further, that were it not for the cross-fertilizing agency of bees, scarcely any of these fruits could be produced in the abundance and perfection in which we now get them, and that to secure the best results and facilitate the work of the bees, it is yet necessary, in the large majority of cases, to mix varieties in the same orchard. Bees were doubtless the earliest embalmers, since they use the propolis to encase and thus prevent the putrefaction of any intruder which is too large for them to drag out of the hive.

There is much, even to-day, in the economy of the Hive Bee that is yet debated among the best informed apiarians, but I will endeavor to give you an epitome of what is absolutely known of its more important habits, structures and functions—the true life-history, so to speak, of the bee. By going somewhat into detail with this species, we may avoid repetition in treating of the other social Hymenoptera, all of which have somewhat similar larvæ and transformations. Let us, in imagination, proceed to an ordinary well-kept apiary. Taking a bee-smoker in one hand—one of the pattern invented by the late M. Quinby of New York—we lift one corner of the hive cover or quilt, and send enough smoke down among the bees to give them to understand that they must submit to our manipulation. Drawing out one of the brood combs, which is rendered easy by the movable frames, thousands of the bees are seen adhering to the surface of the comb. They are mostly workers, but in summer there may be seen numbers of stouter-bodied bees, which are the drones or males. If the bees have not been too much disturbed by the smoke or the removal of the comb, the queen may be seen walking slowly over the surface, surrounded by the workers, who, in deference, recede as she walks along, turning their heads toward her and advancing so as to touch her body with their antennæ. It was long thought that the queen exercises sovereign powers, and Shakespeare voices the popular opinion when, in Henry V, he says:

> "They have a king and officers of sorts."

One of the earliest definitions of a queen bee in Webster's dictionary was, "The sovereign of a swarm of bees." In reality, however, the government of the hive is purely democratic. Each works for the common welfare, and only so long as the individual, whether queen, drone, or worker, is useful to the community, is it spared. With the exception of the drones, the queen is the only bee in the hive having the reproductive organs fully developed, and she is, therefore, the mother of the colony. During the more prolific season she lays two or three eggs in the course of a minute, and often as many as four thousand in twenty-four hours. Three days after deposition of the egg the young larva is hatched. It is the office of the younger workers, known as nurse-bees, to furnish these young larvæ with food, which they are assiduous in doing. In the case of the worker larvæ, five days suffice for full growth, when they nearly fill the cells. As with most other soft-bodied larvæ that are embedded in a semi-liquid nutritious medium, we find provision to prevent contamination of the environmental food with excrementitious matter. The food supply is, in the first place, highly nutritious, and nearly all capable of assimilation. Lest, however, any portion of the waste should enter the food, the larva is, according to Cheshire, rendered incapable of voiding anything during the time of feeding. The arrested development of the digestive system leaves the posterior inflection, which corresponds with the after bowel, unconnected with the middle bowel, and the slight accumulation of waste matter in this latter is cast into the base of the cell at the last molt, and is covered in the bottom of the cell by the lower part of the last cast skin or pellicle, which also serves to line the rest of the cell and leave it clean for the formation of the pupa. Thus, when the young bee emerges, the cell needs but to be brushed out by the workers to be ready to receive another egg or stores of honey and pollen which are to form the winter food.

Just before pupation, or when the larva has acquired full growth, the adult workers cover the cell with a convex lid composed not of wax alone, as in the case of the cappings of honey cells, but of pollen and wax combined. The larva just before pupation strengthens this cap by lining it with silk, which is also slightly attached to the last cast skin. The pupa state lasts some twelve days, and on the twenty-first day from the time the egg was laid, the perfect bee cuts a circular opening in the cell cap and makes its way out. The first care of this young bee is to seek food from an open honey cell, and in the course of two or more days it has acquired sufficient strength and consistence to enable it to begin its labors as a nurse bee, doing for the developing larvæ what was so recently done for it. After a week's time it takes short flights, noting well the location of its hive so as to be able to return to it.

Queens are only bred when a colony is about to swarm, or when an aged or failing queen needs replacing, or where an accident has deprived the hive of her services. If she be removed from the hive during the working season, the bees are thrown into great excitement, shown by the change of the contented hum into one of alarm, by the hurried movements from the combs to the entrance, and by the discontented flight to and from the hive. If all the brood combs are removed the bees become panic-stricken, and give utterance to a peculiar mournful note or distressed wail, quite different from the normal cheerful hum. In time, however, this excitement subsides, as they become satisfied of their loss. If the queen be returned, or a comb containing young larvæ be introduced into the hive, the whole attitude changes. The moment the first bee touches with its antennæ the queen, or a comb, or any point over which she had walked recently, it sets up a loud and cheerful hum, and the occupants of the hive, even those unable to see the comb, immediately catch the sound, and crowd toward the point whence it first proceeded, repeating the jubilant note. If only a comb of larvæ be given them, they still recognize it as a deliverance from the threatened extinction of the colony. In a few hours one of the cells over a larva two or three days old will be enlarged by the partial destruction of the walls of the adjoining cells. This enlarged cell is built outward and downward, and the larva is fed on the so-called royal jelly or bee-milk. The supply of this food is always plentiful, and when a well-developed queen has issued, it is not uncommon to find a quantity of the food, in a partially dried, jelly-like mass, in the bottom of the cell. When, preparatory to swarming, young queens are being reared, the workers have to guard them, even in the cell, from the jealous fury of the reigning queen, and the instinctive rivalry and conflict between queens, accompanied by a peculiar shrill battle-cry, first noticed by the elder Huber, are quite suggestive of similar conflicts between rival queens in human monarchies.

Economy of Hive. Social Organization. Division of Labor.

Each bee, as already stated, labors for the good of the commonwealth of which it is a member. Of them it might well be said:

> "Salus rei publicæ suprema lex."

It is the welfare of the colony which directs the actions of all, and not the will of the queen. Indeed, it would seem that the latter performed her important function—that of supplying the hive with eggs—only when the workers willed it, their own condition of prosperity as regards stores, or their anticipations of the future needs of the colony as regards population, causing them to supply the queen liberally with food rich in nitrogen—a partially digested substance or a gland product, or perhaps a mixture of both, which she alone cannot produce, yet without which any considerable production of eggs is an impossibility. As Evans remarks:

> "The prescient female rears her tender brood
> In strict proportion to the hoarded food."

We must, then, credit the industrious and provident workers with the chief influence in shaping the policy of the hive. They are the *servum pecus*—the living force—of the colony. And to the end that order and efficiency of effort may prevail, they have, we find, a marked division of labor. In the normal condition of the hive the young workers, as already stated, care for the brood—a labor which they take upon themselves within two or three days after issuing from the cell. The glands which secrete a part of the food required by the developing larvæ are active during the earlier part of the life of a worker. Later these nurses become incapable of doing their work well, as the gland system becomes atrophied. When a few days old they take short flights, if the weather favors, but seldom commence gathering stores before they are fifteen days old. Wax production is more essentially a function of the workers in middle life, and it is particularly noticeable that those bees fashioning the wax into combs are principally of this class. Many of those acting as foragers do, however, secrete wax scales, which are doubtless, in the main, utilized. Among the outside workers and hive-defenders some bring honey only on certain trips or for a time; others honey and pollen; others water, and yet others propolis or bee-glue to stop up crevices and glue things fast. Meanwhile some are buzzing their wings at the entrance to ventilate the hive, and others are removing dead bees, dust, or loose fibres of wood from the inside of the hive or from near the entrance, or are guarding this last against intruders, or perhaps driving out the drones when these are no longer needed.

Swarming.—Perhaps there is no action on the part of the Hive Bee which more distinctly indicates its intelligence and power of communication than the act of swarming. The fact that queen brood is being reared in the hive is the best evidence that the colony is preparing for flight or swarming; but, in addition, it is noticeable that on the day of swarming the whole colony is excited, and in a measure has abandoned ordinary duties. For days previous to the event, scouts have been searching for a favorable hollow or crevice or place in which to house the new colony, and when the time finally comes, which is usually in the hotter part of the day, all the individuals of the hive leave after the peculiar preparatory flight around the hive, known as swarming. The impulse to leave is such that many individuals not yet capable of flight, fall to the ground, and the hive is practically abandoned by all those within it at the time of swarming. Individuals alight on some bough or object near by, with a view primarily to organization and the sending out and return of additional scouts. During this period a cluster will remain more or less in repose, but when once the location for a permanent dwelling has been finally determined upon, the whole mass will leave as with one impulse and fly swiftly and directly to the new home. With the first swarm that the new colony sends out it is the old or fertile queen that goes with the new swarm, but with the after swarms, which issue in about a week, it is a virgin queen that accompanies. The old colony begins again with the few individuals unable to follow the departing swarm, and which have crept back to the old hive, with those which at the time of swarming were busy in the field, and with those which issue from the yet undeveloped brood.

It is a popular mistake to suppose that mating takes place during swarming. If a virgin queen goes with the swarm, she subsequently takes the nuptial flight from her new home. As she flies swiftly and strongly, only the strongest and most vigorous drones are able to mate with her, and there is every opportunity for cross-fertilization with drones from some other colony. It has also been noticed that drones have a way of congregating in some particular spot, as though awaiting their chance of thus mating with the queen.

The more important special Organs.

The different structures and organs of the Hive Bee are most interesting, but I can allude only to a few of the more striking. The tongue is a very complex organ, fitted for obtaining minute quantities of nectar from the flowers that secrete it but sparingly, or to remove the same substance rapidly when found in abundance. The figure of the head and appendages thrown on the screen will illustrate this organ in detail. We have here the mandible, mostly used for cutting and moulding the wax, the maxillæ with their palpi, the labium and labial palpi, and finally the ligula or true tongue with its spoon-like tip. This is extremely flexible, and consists of a rod or central portion, nearly surrounded by a sheath which is covered thickly with hairs, which aid, by capillary attraction, in taking up the liquid food. A lapping motion, when the liquid is abundant, causes the liquid to be lodged among the hairs of the tongue, which can be partially drawn into the mentum, and from this point the maxillæ above and the labial palpi below unite to form a tube around it, which is closed above the extension of the epipharynx, and by alternately arching and depressing the maxillæ, the space enclosed is increased or decreased, thus producing suction and drawing the liquid held on the tongue into the opening of the esophagus.

When drawn from the flowers the nectar is thin and watery and lacks the qualities of the delicious honey into which we find it converted when removed from the cells sealed by the bees. This watery substance is evaporated to the proper consistency in the heat of the hive and by currents of air passing over the surface of the combs before the cells are sealed, these currents being created by bees stationed at the entrance and buzzing incessantly. There has been much discussion among apiarians, as among writers, as to whether the bee gathers or makes honey. Strictly speaking it does both. Formic acid is contained in the blood of the bee and especially in the salivary glands, as recently demonstrated by von Planta of Zurich, and when the gathered nectar, which easily ferments, is regurgitated from the first stomach into the cell, it is combined with sufficient formic acid to change the cane sugar into invert sugar (dextrose and levulose in equal proportions) while the evaporating process just described eliminates the superflous water; so that honey which resists fermentation is essentially a made product.

I would also draw your attention to the wax-producing organs (See Fig. 3a, *a*). If we examine the underside of the abdomen of the worker, the exposed portion of each segment will be seen to be covered with a web of hairs, and by elongating the abdomen, each segment, with the exception of the first and sixth, is seen to bear two shallow, irregularly-shaped plates, one on each side of the median ridge, which is extended as a rim around the whole contour. These pale yellow, smooth plates are in reality wax moulds, the wax glands being under the plates and the secreted wax reaching the surface by osmos through the thin membrane and hardening into a somewhat brittle scale, resembling in appearance a minute, nearly transparent fish scale. The wax is secreted under conditions of great heat, the bee ascending for this purpose to the top of the hive, and the wax producers consuming a large amount of honey.

The next structure of importance to which I would call your attention is the wax pincers (Fig. 1b, *a*, *b*), which is a modified structure of the juncture of the tibia and metatarsus of the posterior legs. With these pincers the wax producer plucks a scale from one of its wax plates, passes it rapidly forward to the mouth, and here makes it plastic and at the same time more or less yellow, by continually manipulating and chewing it between the mandibles. Then the bee sticks it to the under surface of the hive cover or object to which the comb is to be attached. More wax is added, forming a slight ridge, which is chiseled or pressed from each side by workers, using their firm and highly polished maxillæ, and placing themselves so that their range of work will overlap just one-half. As this ridge is built down, forming a sheet—the septum upon which the cells are constructed—the sides of the latter are started simultaneously. In their efforts to make the cells concave at the bottom and so as to fit together at the sides without loss of material, mutual pressure results in straight lines, the sides becoming hexagonal in outline, just as six soap-bubbles resting against a seventh cause the latter to assume a hexagonal form; while the bee starting a cell on the bottom of one already commenced on the other side, naturally takes the apex of the latter as a part of the boundary of its own cell in order that the latter may also be concave. Thus three rhomboidal faces forming the base of one cell, form individually a part of each one of three cells on the opposite side.

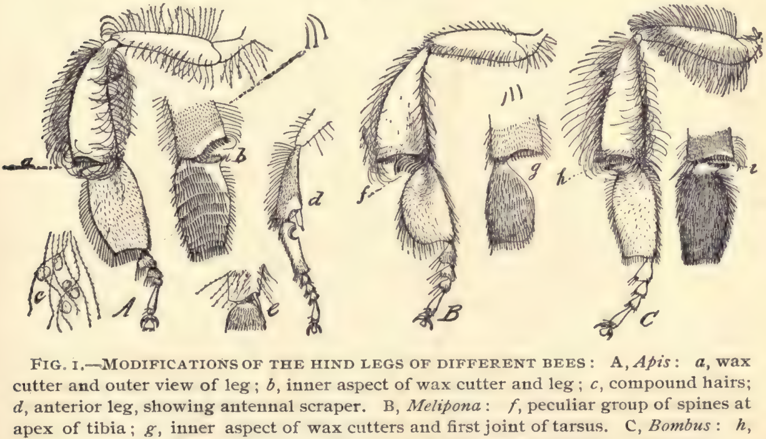

FIG. 1.—MODIFICATIONS OF THE HIND LEGS OF DIFFERENT BEES: A, *Apis*: *a*, wax cutter and outer view of leg; *b*, inner aspect of wax cutter and leg; *c*, compound hairs; *d*, anterior leg, showing antennal scraper. B, *Melipona*: *f*, peculiar group of spines at apex of tibia; *g*, inner aspect of wax cutters and first joint of tarsus. C, *Bombus*: *h*, wax cutter; *i*, inner view of same and first joint of tarsus—all enlarged. (Original.)

Finally I would call your attention to the arrangement of the hairs on the inside and outside of the legs (Fig. 1, A), so well fitted for collecting and holding pollen, and to what is known as the antenna-comb or strigil (Fig. 1, *d*), a structure with which the bee cleanses itself, and especially the antennæ, which are organs of extreme sensibility and need to be kept well cleaned. This structure occurs on the underside of each front leg and is a semi-circular cavity in the upper end of the metatarsus. The cavity is fringed with stiff hairs or spines, forming a comb. The distal or opposing end of the tibia is furnished with a spur, slightly concave on the inner surface and known as the velum When the tibia and metatarsus are bent at right angles, the velum falls over the cavity and forms an almost circular opening just large enough to snugly hold one antenna.

These are the more conspicuous structures, though there are others of minor importance, all indicating remarkable adaptation to special purposes and to the necessities of the bee.

The Hive Bee is but one of many species of its family, and while representing the most highly organized of the social insects, has many cousins and more distant relatives which are equally interesting. The numerous bees, with their diversified habits, have an especial interest, when studied structurally and biologically, as throwing light on the origin and development not only of the higher social habits and intelligences of the true Hive Bee, but also of its structures, so remarkably fitted for their special purposes.

Species of Genus Apis and Variations in Apis mellifica.

The old conception of the Hive Bee, its attributes and structures, was that it exemplifies in a marvelous manner creative wisdom for man's interests. Yet while it represents great perfection of organization and of structure, for particular ends, this perfection is relative and not absolute. Though a number of species of the genus Apis have been characterized by authors, there are but four well defined species so far known, and three of them—*A. dorsata*, *A. indica* and *A. florea* are confined to India and the East Indian and Philippine Islands. The fourth, *Apis mellifica*, or the common Hive Bee, was originally introduced into this country from Europe, and doubtless had its origin in some parts of Asia. It has followed civilized man in his migrations over the globe, and has frequently anteceded him, and, being semi-domesticated, has been more or less influenced by him, as have other domesticated animals. Some ten different types of the species have been characterized by specific names, two of them—viz., *adansoni* Latr. and *unicolor* Latr.—being considered good species by Fredk. Smith, while a still greater number are recognized by local names among apiculturists. These varieties and races show every variation in color through the various shades of black, gray and golden-yellow, as also every variation in disposition, industry, and tendency to swarm, and especially in honey-gathering proclivities. (See Note 1.)

Of the East Indian species only one, *Apis indica*, is cultivated. This bee, which is considerably smaller than our own, building smaller combs composed of smaller cells—36 to the square inch—chooses when wild, a hollow tree or rocky cavity for its home. It is kept to a limited extent by the natives, earthen jars being used for hives, but the yield of honey is small.

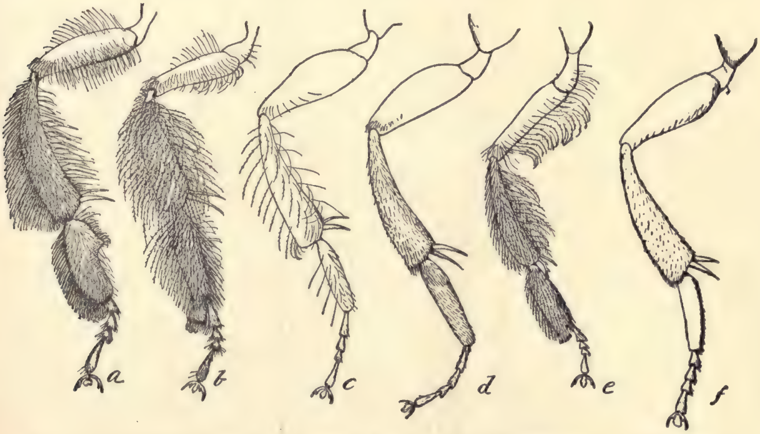

FIG. 2.—MODIFICATIONS OF THE HIND LEGS OF DIFFERENT BEES: *a*, Anthophora; *b*, Melissodes; *c*, Perdita; *d*, Nomada; *e*, Agapostemon; *f*, Nomia—all enlarged. (Original.)

Apis florea, the smallest of the genus, with slender, orange-banded body, builds in the more open country of India, attaching a single tiny comb to the twig of some small shrub. The worker cells are 81 to the square inch of surface, the drone cells 36.

Apis dorsata. the Giant Bee of India, attaches its mammoth combs to the limbs of tall forest trees or to overhanging ledges of rock, generally building a single comb as much as six feet long and two or three feet wide. Great quantities of wax and honey are obtained from this bee by the bee-hunters in India and the islands southeast of Asia. It has not been permanently domesticated; nor is it certain that it can be. The workers of this species are about the size of the queens of *Apis mellifica*, or from seven-eights of an inch to an inch long. The bodies of the bees are slender and wasp-like, and beautifully marked across the abdomen with bright orange bands. (See Note 2.)

While the different species of the genus Apis thus differ in size, coloration, temperament and habit, there is comparatively slight variations in structure; a necessary inference for every zöologist. But if we study the other species of the family Apidæ, we shall find every variation, and obtain a very good idea of how the special organs in Apis may have been evolved and perfected from simpler organs in other genera. This may be illustrated by a few sketches of some of the more important structures, as for instance, the polliniferous organs and the wax producing apparatus. (See Figs. 1, 2 and 3.) The figures already thrown on the screen very well illustrate the fact that the modification of structure and hairy vestiture, which facilitate the collection and transportation of pollen, while exhibited, perhaps, in the greatest perfection in the Hive Bee, is nevertheless an evolution from

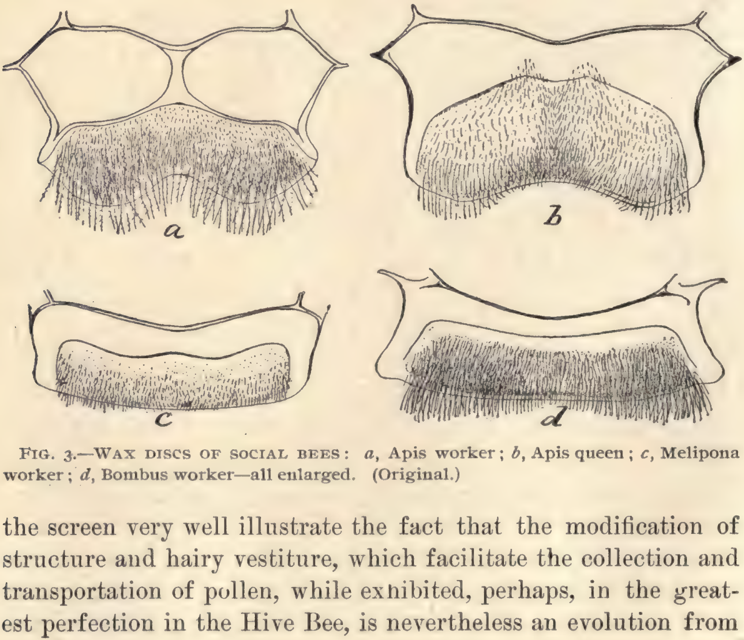

FIG. 3.—WAX DISCS OF SOCIAL BEES: *a*, Apis worker; *b*, Apis queen; *c*, Melipona worker; *d*, Bombus worker—all enlarged. (Original.)

similar structures possessed by other species of social bees, such as the Meliponæ and Bombi, and still more remotely from such as are possessed by the solitary bees. Here again I trust to diagrams, and relegate detailed exposition to a note. (See Note 3 and Figs. 1 and 2.)

In the production of wax the Hive Bee exhibits a lavishness not found in any of the wild bees, not excepting the species of Trigona and Melipona, which approach it most nearly in social economy. As a result we find that the wax-secreting organs of Apis are much larger than in any other wax-producing bees. In Bombus they are greatly reduced and otherwise different in structure, resembling, however, very closely, those obtaining in Melipona and Trigona. In the solitary bees, which produce no wax, these specialized structures are entirely wanting. (See Note 4.) But the most interesting fact is that in the queen bee, in which they are functionless, they are nevertheless present, but more nearly resemble the same structures in Melipona.

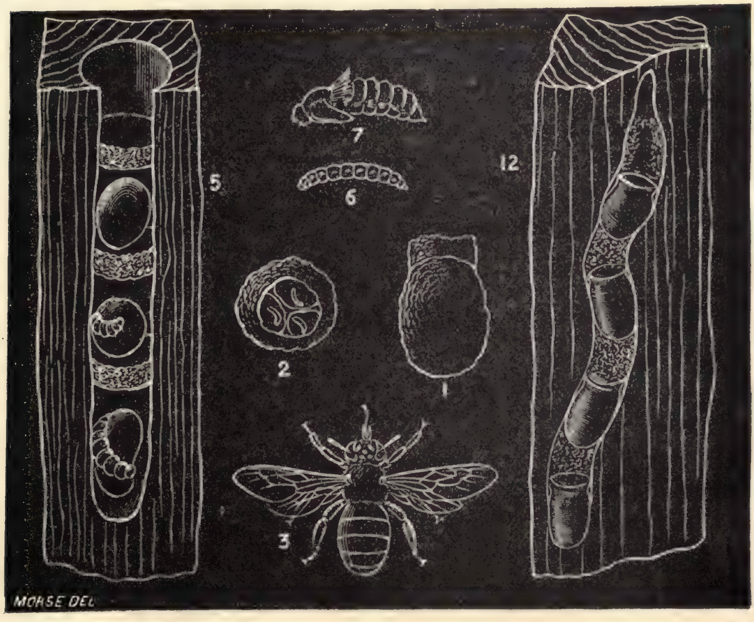

FIG. 4.—ARCHITECTURE OF BEES: 1, cell of bumble-bee; 2, end of same showing eggs; 3, Xylocopa virginica, the carpenter bee; 5, cells of same; 6, larva of bee parsi e, *Anthrax sinuosa*; 7, pupa of Anthrax; 12, cells of mason bee, *Osmia lignivora*—natural size. (After Packard.)

The architecture of certain solitary bees is shown in Figs. 4 and 5. These solitary bees, no matter in what situations or of what material they make their cells, generally store them with honey or pollen, and after depositing an egg, cap the cell and leave the young larva to care for itself. The habits of the social Bumble-bee (Bombus) are but a step in advance, as the larvæ are developed in a mass of pollen and honey, in which they form rather imperfect cells. When full grown each spins a silk cocoon which is thickened by a certain amount of wax, which is added by the adult bees. The females labor and several co-operate in the same nest. In the Bottle-bees (Melipona) a still further step is seen, as the cells, of a rather dark, unctuous wax, are formed into regular combs and are somewhat imperfectly hexagonal. They are, however, in single horizontal tiers, separated and supported by intervening pillars, more like the nests of the social wasps, and the cell is sealed after the egg is laid upon the stored food, just as in the case of solitary bees. The honey is stored in separate flask-like cells, and but one queen is allowed to provide eggs.

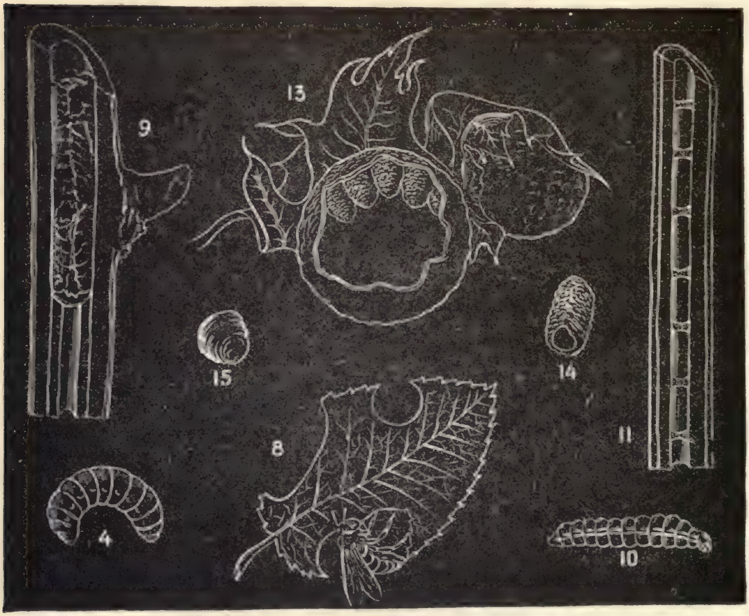

FIG. 5.—ARCHITECTURE OF BEES (continued): 4, larva of *Xylocopa*; 8, leaf-cutter bee, *Megachile*; 9, cells of *Megachile* in elder; 10, larva of upholsterer bee, *Ceratina dupla*—enlarged; 11, cells of same in elder, ; 13, cells of *Osmia similima* in deserted oak-gall; 14, earthern cell of same; 15, pollen mass of Osmia—natural size (After Packard.)

SOCIAL WASPS.

The popular conception of these interesting insects is decidedly at variance with their deserts. Wasps are generally considered as thieves, robbers, idlers and vagabonds; as impertinent and inquisitive, invading our homes and devouring anything and everything their fancy craves, as sugar, fruit, meat, wines, etc., and resenting any interference in such a pointed way as to bring pain and rage to the incautious or meddlesome individual who interferes with their operations. The term "waspish," one of the most expressive in the language, very well denotes the popular feeling towards these somewhat maligned insects. Granted that toward other insects they are cruel, and that they courageously resent interference, yet the fact remains that they are seldom, if ever, the original aggressors in the infliction of punishment, except in the capture and appropriation of other insects as food—a course which finds its counterpart in every other carnivorous insect or higher animal, and is justified even by the example of man himself. In their relationship with each other, the wasps are polished and gentle, and never quarrelsome so far as their own species are concerned; and they never turn robbers or marauders of their own kind, as do the more lauded bees, among which we have what are known as the corsair bees, which frequently rob their sisters of the sweets and pollen which they have collected with great pains and indefatigable industry. These robbers even lie in wait, and scheme and plan in bodies for the success of their raids, as do thieves among men. Wasps never resort to such cowardly proceedings, and hence strictly speaking, are not robbers at all; for aside from their own kind the world is their legitimate pray.

The family Vespidæ, to which the wasps and hornets belong, comprises some thousand known species. They closely resemble bees, but differ in possessing more cylindrical bodies with a harder, smoother integument. The wings are longer and folded once longitudinally, and when at rest are laid flat on the body. The antennæ are elbowed, and the jaws are large and powerful. Their eggs are at first nearly spherical, but rapidly become ovoid. Their larvæ, as in the other social Hymenoptera, are legless and helpless grubs, entirely dependent on the adults for food and care. The family comprises two natural groups, viz., the Social

Wasps, having, as with bees and ants, three forms—males, females, and workers or neuters; and the solitary species, in which only females and males occur.

The common Bald-faced Hornet (*Vespa maculata*) is a familiar example of the first-named group. It constructs remarkable nests of various patterns, of a gray, paper-like material, and suspended to the branches of trees and shrubs, or to the rafters of houses. In the second group, on the contrary, the species construct cells or nests, consisting usually of single cells, of sand or mud, in protected situations; store them with insect food for the larvæ, and then abandon them altogether. The former—"natural paper-makers from the beginning of time," as Harris properly styles them—have always done what man, with all his boasted superiority, has only in recent times learned to do; viz., make paper of wood. They resort for this purpose to such woody surfaces as have long been exposed to and bleached by the action of the elements. With their powerful mandibles they tear off minute filaments and chew them into a fine pulp, which they afterward spread into a thin sheet of strong, water-proof paper, out of which they construct their nests. These nests are of two kinds, one made by the true Vespas, as in the case of the Bald-faced Hornet just alluded to. Here the outer covering forms a more or less regular globose body, with a single circular orifice at the bottom, the combs being arranged within this covering in horizontal tiers or stories. In the second category we have the nests of the wasps belonging to the genus Polistes, which are more particularly known by the name of paper wasps. Here the nest has no outer envelope, and is usually limited to a single tier of cells suspended by one or more peduncles or short stems. Thay are usually attached in the open air to the branchs of trees, or are fastened to the underside of the rafters of porches, etc., garrets being favorite places for their construction. Some of the hornets, such as the "yellow-jackets," are found occupying the deserted nests of mice, suspending the tiers of cells from the ceiling and lining the burrow with a layer of woody paper. The burrows are enlarged from time to time as the growth of the colony requires additional space, and in late autumn are often found large enough to fill a bushel measure, containing sometimes from 15,000 to 20,000 cells. In all these cases the tiers of cells are attached to each other or to other supports by strong pillars of the same *papier maché* material, but of darker color and firmer texture.

The combs of these paper wasps and hornets are not double, as in the case of the Hive Bee, and the cells, which are less perfectly hexagonal, have the mouth beneath and are in horizontal instead of vertical layers. They differ from the cells of bees, also, in that they are used solely in the reception of the larvæ and, except in some tropical species,* not for the storage of honey or pollen. The nests of wasps vary greatly in the different species, and find their greatest perfection in the card-making species of Cayenne (*Chartergus nidulans*) the outer covering of which is nearly white and as tough as the stoutest card-board.

The life-history is very interesting. Perfect females or queens and males are produced in the autumn, in cells of large size, and in the case of the hornets proper, these are developed in the lowest and last constructed of the cells. The males and the workers or imperfect females, perish at approach of winter, while some of the fertile females hibernate in sheltered situations. These, in the following spring, originate new colonies, and may be seen about early spring flowers, which they frequent for honey. but more particularly to prey upon other insects attracted to the blossoms. Singly and unaided they originate the new colony, building cell after cell, supplying each with an egg, and persistently bringing home food for the growing young. All these cells in the early season produce neuters or working females only. These, as soon as developed, assist the hibernated mother or queen in the enlargment of the nest and the care of the young. She, after having once started her colony, rarely leaves it, but remains and devotes herself solely to the duty of egg-laying. The workers become by far the most numerous, and by late summer are everywhere found moving actively about in search of food for the home brood. They are less than half the size of the perfect females, and considerably smaller than the males, which are easily distinguished by their more slender bodies and very long antennæ. The males are not mere idlers, as in the case of the bees, but occupy themselves with various labors about the nest, and while the male bee is in the end ruthlessly destroyed

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*St. Fargeau states that he has often, in *Polistes gallica,* found cells filled with honey.

by the indignant workers, the male wasp is respected and protected, and dies a natural death. In the large nests of hornets, the number of males and perfect females produced in the autumn amounts to several hundred, and of these comparatively few females successfully hibernate. Were it otherwise ordained, these insects would become too numerous for the comfort of the rest of the world.

The larvæ are fed from day to day with a prepared liquid food which is disgorged from stomachs of the adults. These prey upon other insects, and also feed upon animal or vegetable matter to which they have access, and are particularly fond of the sweets of fruits, melons, etc., also of sugars and honey, all of which are eaten greedily, and commingled and prepared in the stomach as food for the young. Wasps are not particularly active themselves in the collection of honey from flowers, but are very prone to rob the hives of bees whenever opportunity offers.

We have seen that in the case of the Hive Bee the unfertilized egg, including the egg deposited by the worker bee, invariably produces a drone or male. The experience of English observers, indicates that the reverse of this is true of the social wasps, and that, instead of males being produced from eggs of workers or non-fertilized wasps, other workers similar to the parent are produced. Thus from nests from which the queen wasp is removed quite early in the spring, the generation of workers continues through the season as freely as if the queen were still present to lay eggs, showing that the brood is kept up by the progeny of workers having no access to males, which only appear in the fall. Leuckart has also shown, by careful dissections, that nearly fifty per cent. of the worker generations in the latter part of the summer at least, have fully developed and developing eggs in their ovaries.

It must be noted, however, that the experience of Von Siebold with *Polistes gallica* directly contradicts the observations of English investigators. His experiments carried on in precisely the same way, indicate that, with this species at least, the eggs from the workers produce males. There would, therefore, seem to be no uniformity in this regard among the different species of the family, both arrenotoky and thelytoky occuring among them, and possibly in the same species at different seasons.

In the case of Vespa there is no difficulty in separating the fertilized autumnal queen from the worker generations, the former being considerably larger and presenting even more marked differences from the worker than occur in the similar states of the bee. With Polisites, however, the difference between the fertilized queen and the summer broods of workers is much less marked, and it is more difficult to distinguish them. The abdomen of the true queen of Polistes is somewhat longer and larger than that of the worker, but the variation is so slight that accurate separation is usually impossible, and there is probably less difference between the worker and the fertilized female than obtains with the social bees, the worker being quite capable, in many cases at least, of producing eggs which will develop into other workers, and at the proper season also, doubtless, into males. The distinction between the summer broods and the autumnal females which are fertilized and hibernate, is probably produced by food conditions, as in the case of bees, although accurate observations are wanting.

Just as in the case of bees, the study of the wasp family (Vespidæ) in its different genera and species, reveals every gradation in habit, from the solitary species to the more highly organized or social forms, and these differences in habit are accompanied by differences in structure, so that the origin of the higher or more social forms may be traced through the less specialized.

Many instances might be cited in illustration of the great intelligence of wasps, and especially in proof of their wonderful sense of direction. On the whole they exhibit a rather higher degree of intelligence than do the bees, in the remarkably varied provisions which they make for their young. Their habitations, also, complete in themselves, and built chiefly of extraneous matter not secreted from their own bodies, indicate greater architectural dexterity than is found in the bees.

ANTS.

Few insects have attracted more attention, or have become more renowned than the ants. Considering their comparatively diminutive size, their endless activity, and the wonderful results they accomplish, this is not to wondered at.

Up to the present time some fifteen hundred species of ants have been described, the great majority of the species, as well as the largest and most rapacious, occuring in tropical and semitropical countries. Some two hundred species have already been described from North America, many of which are nearly related to or even identical with those of Europe; while some are cosmopolitan, having been distributed by the agency of man over almost every part of the world. One of the best known of these cosmopolitan forms is the the little Red Ant, *Monomorium pharaonis* Linn., a grievous household pest. Under the tribal term *Heterogyna* Latreille, the ants are divided by the later systematists into four families (by some considered sub-families), namely, the Formicidæ, the Poneridæ, the Dorilidæ and the Myrmicidæ. The first family, Formicidæ, comprises all those species which are destitute of a sting, except in the genus Œcophylla, and are further characterized by having but one node or scale connecting the abdomen with the thorax, and by the habit in the larva of constructing for pupation, a dense, smooth, ovoid, silken cocoon. The remaining families are possessed of a sting, the Poneridæ agreeing with the Formicidæ in the cocoon-forming habit of the larva and in having but a single node or scale connecting the thorax and abdomen, but having an additional, more or less pronounced constriction between the first and second abdominal joints. The Dorilidæ are somewhat aberrant, the female and worker, so far as known, being blind, and nothing being yet known of their larvæ. In the last family, the Myrmicidæ, there are two well-developed, freely mobile nodes between the abdomen and the thorax, and the larvæ are unprotected by any cocoon during pupation. The most interesting and destructive species occur in this family.

Let us glance briefly at some of the species, more according to habit, however, than this classification, and preferably our North American species. Thus they may be considered as Carpenter, Mound-building, Harvesting, Honey, Leaf-cutting, Nest-building and Driving or Foraging ants. (Note 5.)

Ant Economy and Habits.

ANT WARS.—Very many most interesting accounts of the intelligence and battles, and of the curious persistency of ants, especially of the foraging species, are recorded by travellers in tropical countries, and particularly by the late Henry Walter Bates in his "Naturalist on the River Amazons". It is a well established fact that ants, like human beings, do at times declare war against other species, or even against colonies of their own, while with many species there is a form of neuter known as the soldier which seems to be developed for no other purpose than to defend the colony or make war upon some other colony. The soldiers are characterized by an enormous and abnormal enlargement of the head, jaws and mouth-parts. In these wars the greatest pugnacity and courage are exhibited, the contest lasting sometimes for days, and the weaker party ultimately succumbing from sheer exhaustion and decimation.

There is a gradation in the warlike spirit in different species and genera. Thus in Myrmecina and Tetramorium the ants do not fight, but roll up and feign death. Lubbock shows that in *Formica exsecta*, an active but delicate species, the individuals advance in serried masses, and that when fighting with larger species, like *Formica pratensis*, several in unison, attack an individual of the latter, some of them jumping onto the back of the foe and sawing off the head from behind. The species of Lazius, he says, will suffer themselves to be cut to pieces rather than let go when they have once seized an enemy, while *Polyergus rufescens*, the notorious slave-making ant of the Amazons, seizes the head of her enemy by closing the jaws, so as to pierce the brain, thus paralyzing the nervous system; so that a comparatively small force of Polyergus will fearlessly attack much larger armies of the small species and suffer scarcely any loss themselves.

SLAVE-MAKING.—Nor must I pass without brief mention of another fact which has been well observed among ants, namely, that some of the species repeatedly raid the colonies of weaker ants and make slaves of them. In most cases it is a large pale ant which enslaves a small black ant, and this is done either by capturing fully developed workers or more often by carrying home from the weaker colony larvæ and pupæ and allowing these to develop in the formicaries of their masters.

It is most interesting to note, also, that the slave-making habit among ants produces the same demoralizing results for the slave-maker that it does among men. The habit is degrading. Thus, as Lubbock points out, *Polyergus rufescens* has become entirely dependent on its slaves. It has lost the power of building, as also most of its domestic habits. Its impotence away from its slaves has gone so far that even the habit of feeding has been lost, and it will starve in the midst of plenty rather than feed itself.

Such cases as this, of an animal having lost the instinct of feeding, are extremely rare in nature, but the habit here has even affected the structure, for the mandibles of the slave-makers have lost their teeth and are useless except as weapons of war.

BURIAL GROUNDS.—It would seem almost incredible, but there is nevertheless good evidence that some species of ants habitually form burial grounds for the dead. An esteemed friend and reliable observer, Mr. Henry G. Hubbard, informs me that he has carefully studied the habits of a black mound-making ant in Montana, (*Formica subpolita Mayr*), the mounds being made in dry situations in the mountains. There are always burial pits just outside the hill, connected with it by passages; and these burial pits contain generally a double handful of dead ants, with occasional fragments of other insects. They are made in firm, hard soil, and consist of a clean neat chamber, sometimes as large as one's two fists. In moist ground the same species of ant does not seem to use the same method of burial. These facts are all the more interesting as showing how the same species may develop a local habit, as *subopolita* is now considered but a variety or subspecies of the widespread *F. fusca* L.

FOOD-HABITS.—In Note 5, in speaking of the several species, I have recorded in detail some food-habits of our ants. Taken as a whole they are truly omnivorous, feeding upon all sorts of plant and animal matter, storing various kinds of vegetation, and even, as in the case of the leaf-cutter ants, cultivating certain fungus growths for food, but particularly relishing the sweets obtainable from plants and other sources, and more especially from the excrementitious and other secretions of plant-lice and bark-lice.

KEEPING AND RAISING KINE.—There is no work upon ants which does not refer to their well-known habit of guarding and encouraging plant-lice, protecting them from their enemies, and in other ways looking after their welfare. This attitude toward various species of Aphididæ is essentially selfish, as these, when carressed, yield a sweetened liquid which the ants much covet. For this reason the Aphides have been denominated, in popular parlance, the ants' milch-cows. Certain species of plant-lice are frequently attended by particular species of ants, and there is often a remarkable colorational harmony between a particular ant and the Aphidid colony which it cherishes. It is not generally known, however, that the ants do more, and show an exceptional intelligence in carrying the eggs of the plant-lice in autumn into their own formicaries, bringing them together in little heaps and taking every precaution to preserve them through the winter These eggs are carried back in spring to the plant upon which the particular Aphidid is nourished. There are, moreover, a number of other insects which the ants foster in their homes and from which they obtain coveted secretions; so that they may be said to utilize various kinds of cattle.

EARLY STAGES OF ANTS.—The transformations of ants are similar to those of other social Hymenoptera where the young are fed and cared for by the workers or nurses. The eggs are, as a rule, deposited by what may be called queens, i. e., by females more highly fed and developed than the rest, and devoted solely to the propagation of the species. It has also been noted that, in an emergency, where the females have perished, eggs may be deposited by the workers, as in the case of the Hive Bee, and also, as in that case, that these unfertilized eggs produce males only.

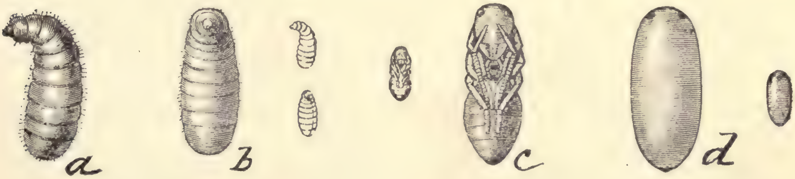


FIG. 6.—DEVELOPMENT OF FORMICA RUFA : *a*, larva, lateral ; *b*, do., ventral view ; *c*, pupa ; *d*, cocoon—enlarged, the outlines showing natural size. (After Dalton.)

The eggs are yellowish-white, ovoid or oblong-ovoid, very delicate in texture, and require from two to three weeks, or longer, for hatching, according to seasonal conditions. The larvæ are soft, white, legless grubs, having no eyes and being perfectly helpless. The small head is curved down on the breast and provided with but rudimentary mandibles. There is at first no apparent difference between the larvæ destined to produce the different kinds of individuals, but the growth of those destined to become workers suddenly ceases, whereas that of those destined to become perfect females, continues. As in the case of the larvæ of the bee, the workers are therefore but arrested or undeveloped females, and there is every reason to believe that the ultimate organization is a result of a difference in the kind of food or amount of food supplied by the nurses; so that practically the constitution of the formicary is regulated by the colony itself. The helpless larvæ and pupæ are moved from place to place, and most tenderly cared for by the nurses, which understand the requisite conditions of warmth, fresh air, protection against cold, rain, and other injurious influences, and which feed their young charges with a liquid discharged from the mouth, very much as in the case of the bee.

While the mandibles are used for tearing all sorts of substances, it is the juices of these which are lapped up by the tongue, and which can be regurgitated from a fore-stomach or pouch, in order to feed the young and the queens. These young are, also, arranged by the workers in groups of different sizes and ages, with a view to regulate the amount of food necessary for each stage. The larval life varies very much, so far as observations have been made, as its duration may extend from six or seven weeks to several months, according to the species. Some species even hibernate in the larva state. I have already indicated the differences in habit as to the formation of a cocoon or pupation without a cocoon, in the different families of the group; but a difference is noticeable in this respect, even in the same formicary, as first observed by Latreille. Those which pupate in cocoons are often unable to extricate themselves when mature, and are then tenderly assisted by the workers, who also aid in the unfolding of the wings, and cleansing of the newly-developed ant. (Fig. 6, shows a typical larva, nymph and cocoon).

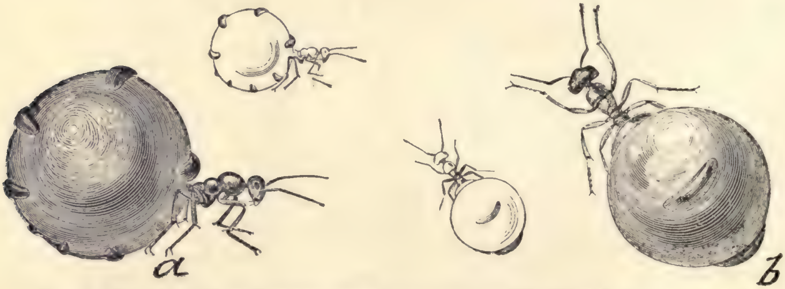


FIG. 7.—HONEY ANTS: *Myrmecocistus mexicanus*; *a*, side view; *b*, from above—enlarged, the outlines showing natural size. (after Lubbock.)

The individuals of the formicary are therefore composed (1) of neuters or workers, which are all females arrested in development; (2) of males; and (3) of fully developed females or queens. All the males and females acquire wings, which are, however, torn off after the marriage flight, and a number of queens are supported in each formicary. In some of the species the workers are uniform in appearance, while in others they exhibit great differences in size and structure. As already stated, the workers or neuters are generally divided into two classes, viz., the ordinary small kind, and a second kind with much larger head and mandibles, and called soldiers. Bates has shown that in the Sauba ant of South America (*Œcodoma cephalotes*) there are two forms of the large-headed neuters, one with hairy and the other with polished head.

LENGTH OF LIFE IN ANTS.—Lubbock's experiments have shown that in some species the mature workers will live from one to six years, and the females even much longer, the life of the males being very ephemeral and lasting but a few days or weeks. He kept a female of *Formica fusca* for thirteen years.

MIGRATIONS.—There are two kinds of ant migrations. The swarming of the sexes takes place usually in the afternoon or toward evening on warm or sultry days, and it is remarkable how very general, over a wide extent of country, the same species will begin to fill the air on some particular day. Species of the genera Lasius, Formica, Tetramorium, and Cremastogaster, particularly, often form dense swarms or clouds, ascending high up into the air. These swarms of ants have sometimes been known to be so dense and persistent that it was impossible, over large areas, to put the foot down without crushing dozens of the insects which have been swept together in vast piles. A case is on record of a large species covering the surface of the water at sea to a depth of six inches, and for a distance of six miles. This congregating in such vast swarms is due to the uniform and simultaneous hatching and development in all the colonies over a large extent of country.

The migrations of the sexes are really love excursions, whereas the migrations of the workers, which take place in vast bodies at times, are a result of undue multiplication, and are intended to improve the condition of the surplus progeny and found new colonies.

MYRMECOPHILÆ.—A most interesting lecture might be devoted to the subject of myrmecophilous insects alone. Ants are as a rule hostile to every other living thing, except such as the plant-lice, which furnish them with desired sweets. They fiercely resent any intrusion into their nests, and often attack and kill their own kind if belonging to another colony. It is therefore remarkable that careful examination of almost any formicary will reveal the presence of a multitude of different insects which appear to live peaceably in the company of the legitimate inhabitants. A mere list of these myrmecophilous insects would be of little interest. The species comprise, first, those which, in the larva and pupa states, live among the ants; secondly, accidental visitors, not confined to ants' nests; and, thirdly, the true myrmecophilous species, i. e., those which in the imago state, and so far as known in the adolescent states also, are exclusively found in ants' nests and depend for their existence on the ants. In some species of the second category we already find a tendency to simulate in color the ant itself, or the surroundings of the formicary; but the true myrmecophilæ, or species of the third class, often mimic in the most remarkable manner the host upon which they depend. Some of these myrmecophilous species are mere scavengers, and feed upon the offal, of an animal or vegetal nature, which is always found abundantly in the nests of ants. They are endured with indifference by the ants, because they are useful in an indirect way, helping in the performance of a duty which would otherwise have to be performed by the ants themselves. Another group is present as marauders, living in the nests for the purpose of stealing and devouring the ants' eggs, larvæ or pupæ, whenever a chance offers. To this group belong the various Histeridæ, a Coleopterous family in which the species are so constructed that it is impossible for the ants to advantageously attack them. In the third group we find species characterized by sweet secretions, from which the ants derive benefit. In some cases, as in the black, clumsy beetles of the genus Cremastochilus, the insects are not absolutely confined to the formicary, though they are always developed there. Frequently in the perfect state they endeavor to escape, and it is curious to note the strategy which the ants employ to prevent the departure of these inquilines or guests from which they obtain the coveted sweet. In such cases, as in the well known genus Claviger, and allied genera, the insects are absolutely dependent on the ants, which take the same tender care of them that they do of their own young, feeding them and keeping them clean, and in every way showing the utmost friendship.

TERMITES OR WHITE ANTS.

The Termites or White Ants have developed, in their higher forms, an organization and a differentation of individuals very similar to those of the true ants; whence the popular name. They are among the oldest insects, as their remains are found in the coal measures of Europe, whereas the true ants do not appear until the Tertiary. Belonging, in fact, to an order which has been very generally looked upon as the lowest or least developed among the Hexapods and as representing most nearly the earlier or primitive insects which appeared upon the globe, the fact that they have acquired a social organization which in so many respects recalls that of the ants, is of great significance, as we shall see when we come to consider the origin and development of these traits. Yet a more intimate acquaintance with the facts concerning the Termites shows us that the development of the social habit and the differentation of forms, have been along different lines from those presented by the social Hymenoptera, and are based upon a different mode of development. In other words, the Termites, belonging to an order which undergoes incomplete metamorphoses—the larva being born in the image of the adult, minus wings—is more or less capable of self-support soon after birth, while in the social Hymenoptera, which undergo a complete metamorphosis, the larva is quite unlike the adult, and entirely helpless during development.

It is only within recent years that the Termites have been carefully studied. The results of these later studies must be relegated to a note. (Note 6). While with most species the colony consists of a king and a queen and of two forms of neuters or workers; yet in the European *Termes lucifugus* as many as fifteen distinct forms have been characterized, but no true queen discovered. In other words, besides the four distinctive classes of individuals which characterize the more highly developed species, we find, sometimes in the same species, but particularly when the different species are considered, every gradation between these different classes.

The fundamental difference between the social Hymenoptera on the one hand, and the Termites on the other, is that in the latter the workers or neuters (including the soldiers) are not undeveloped females, but consist of both sexes, and are in reality arrested or modified larvæ, in which the sexual organs are but imperfectly developed or are completely atrophied. They are recognizable as neuters even after the first larval molt. The common North American species, *Termes flavipes*, is doubtless familiar to most of you. It occurs in vast numbers in rotten or prostrate logs, and frequently invades our houses wherever there is wood in process of decay. The newly-hatched young are very tender and helpless, and move but little, and while in the order Neuroptera the young larva is usually able to care for itself immediately after birth, the newly hatched Termite has become more or less dependent upon the care of the workers, which either feed it with partly digested food from their own mouths, or with their own secretions, or else prepare food for it. The eggs are laid in large numbers by fertile females or supplementary queens, but are carried long distances by the workers into chambers which are generally several feet underground, or else in the heart of otherwise solid trees.

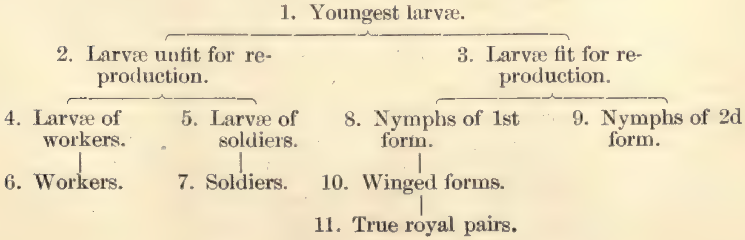
The queen in those species which normally possess one to each colony, becomes helpless as she increases in size and gravity, for she attains to many times the bulk of the ordinary neuters, which are always unwinged. Winged males and females develop from a special brood, and often in such numbers that in spring they swarm until they literally fill the air. They are distinguished from the rest by being more chitinized and darker in color. The great majority of the swarming sexed individuals are doomed to perish, either while on the wing or after falling to the ground, for they are the favorite food of almost all other creatures. But even where not devoured, most of them die without founding new colonies. Swarming is not for the purpose of mating, but it is to be looked upon as an incident in the excessive multiplication of the species, and as a means of inducing cross-fertilization between different colonies.

Upon settling on the ground, the swarming individuals cast off their wings, and if a couple of opposite sex are fortunate enough to enter the outlying burrows of some colony already founded, or to meet a few workers, they are capable of founding a colony themselves. It is only after a female has been duly provided with a place of shelter or cavity that the mating really takes place, from which time forth she becomes more or less stationary and extremely fecund. She becomes, in short, a true queen, and her escort remains with her and has been called a true king; for here again the Termites differ radically from the social Hymenoptera in that coition takes place repeatedly. There are, however, supplemental queens or nymph queens, which seem to be capable of laying eggs, probably parthenogenetically, and which never develop their wings.

The great majority of the neuters are true workers, but a certain proportion of them, about one per cent., are so-called soldiers, having enormously developed heads and powerful jaws, very much as in the true soldier-ants, and fitted for no other purpose than the defence of the colony. Both kinds of neuters are perfectly blind.

The habits and economy of our *Termes flavipes* may be looked upon as typical of the family; but there are species in different parts of the world in which (as in Calotermes) the workers, or (as in Anoplotermes) the soldiers, are absent; others (as in Eutermes) where the soldiers (nasuti) have a bill instead of jaws; others in which the reproductive forms are reduced to the one royal pair; and though the fact has not been absolutely observed, there are probably Termites which produce only males and females, as with ordinary insects, or as in allied families of the Neuroptera. The accompanying diagram will very well illustrate the modes of development and genealogy of the different forms in a typical Termite colony, while some additional sexual forms of less certain character or fixity, have been observed by Grassi in the European *Termes lucifugus*, and called complementary kings and queens. In those colonies which have no true royal pair, their place is taken by supplementary royal pairs. (Note 6.)

Forms in a Termes Colony under normal Conditions.



The fecundity of the true queen Termite is something remarkable, and, based on Smeathman's observations on an African species (*Termes bellicosus*) the fact that an egg is produced every second, or some 80,000 a day in the height of the breeding season, has been commonly quoted among writers on the subject. In this species the queen is sealed up in a cell which is as hard as a stone, in the central and most protected part of the termitary, the cell being opened and enlarged from time to time by the workers, and being also perforated by holes which admit the workers to care for and feed her, while preventing the egress of the female and her attendant male escort.

Among the more curious facts connected with these Termites, because of their exceptional nature, is the late development of the internal sexual organs in the reproductive forms and the existence of a single long-lived male—a condition not parelleled among other insects, so far as I am aware. Further, as Dr. Hagen has pointed out, the queen represents a unique instance among insects of actual growth taking place in the imago state; for the intra-segmental ligaments not only expand, but grow with the increasing gravity of the abdomen, the stigmata actually taking part in this growth, though the dorsal abdominal plates remain unaffected.

In the Hive Bee multiplication of colonies takes place by division, but the colonizing swarm carries in itself all the elements necessary for the foundation of a new colony. In the more typical Termites multiplication of colonies also takes place by division, but this is carried out by the neuters and the various adolescent stages, since there is usually but one true queen, which can not be moved. The new colony, therefore, can only obtain a true queen by introducing one of the royal pairs that wander about after they have swarmed and thrown off their wings. That great difficulty attends the establishment of such a royal pair of individuals in a colony is illustrated by the fact that they are rarely discovered among colonies of our commoner species of Termes proper.*

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*From the accounts of authors there is no difficulty in finding the true queen in most of the nest building species of Eutermes in the West Indies, Central and South America; while from Smeathman's famous account of *Termes bellicosus* in Africa, it would seem that the fertile queen is usually present in the colonies. But in the species most studied, viz., *Termes lucifu-*

The Termites thus exhibit a greater variety of resources for the perpetuation of the species, in case of emergency, than even the social Hymenoptera, and they also exhibit a greater variety of individual forms in the same colony. There is also among the different species, and especially among the different genera, a gradation from the simple to the more complex economy. Their habitations also vary from the simple to the more complete.

Calotermes burrows in the branches of trees and requires no specialized cells or chambers. *Termes flavipes* and allied species make extensive excavations in prostrate logs or the beams of houses, and are very destructive to old books, especially in dark and damp situations. The excavations are usually elongate and separated by partitions which are penetrated occasionally so as to connect the whole. The walls are lined with a thin layer of brown excrementitious matter, and some of the chambers are more particularly used to store eggs in, while others are used as nurseries for the young. Subterranean galleries often extend some distance away from the main termitary, and sometimes up under the bark of trees. More rarely they are exposed above ground, when the insects thicken the layer of excrementitious matter.

Eutermes, which is common in the West Indies and in Central and South America, builds exterior nests more or less spherical or conical, generally at the base of trees, but also on the branches or on stone walls. They are often as large as a hogshead, and consist chiefly of excrementitious matter and of collected particles of decayed wood. There are one or more queen cells in the most protected parts of the nest, and other chambers for the eggs and young, while temporary enlargements afford shelter for the winged individuals before swarming. Covered galleries somewhat thicker than an ordinary pencil, and composed of the same material as the nest, but less compact, extend from the main nest to the ground, or up the tallest trees, leading to food supplies.

The constructional faculty is yet more highly developed in the

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gus, the difficulties in procuring a true queen would seem to be very great, and Prof. Grassi, in five years' observations, has never found one. Yet he had no difficulty in obtaining true kings and queens in confinement by establishing little colonies of winged individuals. The same condition of things prevails with our North American *Termes flavipes*, since in my own observations and those of others, no true queen has been met with, and reproduction is carried on, for the most part, by supplementary queens.

hill-making species of the genus Termes, which attain greatest perfection in South Africa. These nests always arise from the ground, and vary according to the species. They are made of finely comminuted wood, mixed with some secretion, or of clay, in which case they become as hard as stone. Long subterranean foraging galleries are extended from these nests.

In South America some species seem merely to excavate subterranean galleries in the soil, while Bates found at Santarem, Brazil, composite nests occupied by different species, which built each its own part of the nest with its own special material.

SOME GENERALIZATIONS.

In the hasty summary which I have thus endeavored to present to you of some of the chief characteristics of social insects, those who are most familiar with the facts can best appreciate how much of interest has been omitted. These insects are attacked by various natural enemies in their own class, and particularly in the case of the bees and wasps, by some of the most abnormal parasites, viz., the Stylopidæ, in which the young larva is extremely active, but the adult female stationary and so degraded that she has lost all members and mouth-parts, and in fact all semblance of an insect, while the adult male is an active, winged creature, of very ephemeral existence. Chapters might be written upon the myrmecophilous and termitophilous insects of various orders, some of which are mere mess-mates, others advantageous associates, while others are unwelcome, but more or less successful intruders on the hospitality of their hosts. This part of the subject must, however, be passed over in order to permit me to close with some generalizations and speculations which the facts already enumerated provoke.

THE SENSES IN INSECTS.

Having thus dealt, in a summary way, with some of the structures and economies of the social insects, let us now consider their psychological manifestations.

Of the five ordinary senses recognized in ourselves and most higher animals, insects have, beyond all doubt, the sense of sight, and there can be as little question that they possess the senses of touch, taste, smell and hearing. Yet, save, perhaps, that of touch, none of these senses, as possessed by insects, can be strictly compared with our own, while there is the best of evidence that insects possess other senses which we do not, and that they have sense organs with which we have none to compare. He who tries to comprehend the mechanism of our own senses—the manner in which the subtler sensations are conveyed to the brain—will realize how little we know thereof after all that has been written. It is not to be wondered at, therefore, that authors should differ as to the nature of many of the sense organs of insects, or that there should be little or no absolute knowledge of the manner in which the senses act upon them. The solution of psychical problems may never, indeed, be obtained, so infinitely minute are the ultimate atoms of matter; and those who have given most attention to the subject must echo the sentiment of Lubbock, that the principle impression which the more recent works on the intelligence and senses of animals leave on the mind, is, that we know very little indeed on the subject. We can but empirically observe

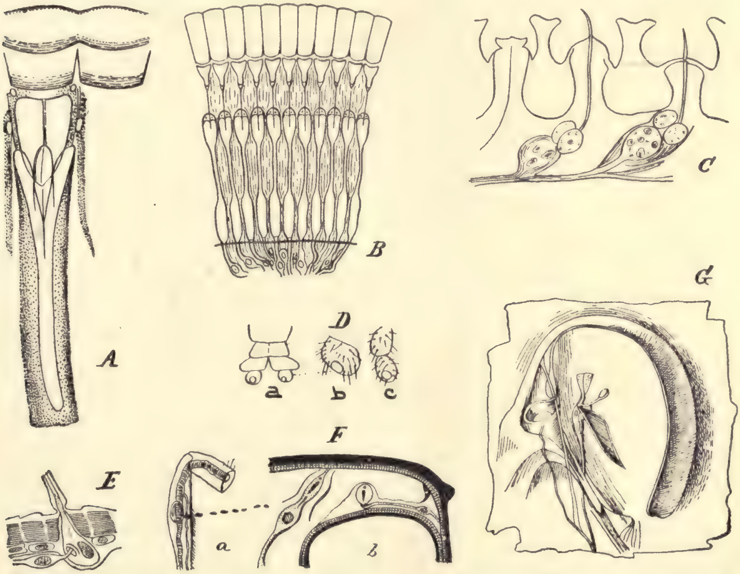

FIG. 8.—SENSORY ORGANS IN INSECTS: *A*, one element of the eye of Cockroach (after Grenacher); *B*, diagrammatic section of compound eye in insect (after Miall & Denny); *C*, organs of smell in Melolontha (after Kraepelin); *D*, *a*, *b*, sense organs of abdominal appendages of Chrysopila, *c*, small pit on terminal joint of palpus in Perla (after Packard); *E*, diagram of sensory ear of insect (after Miall & Denny); *F*, auditory apparatus of Meconema, *a*, fore tibia of this locust, *b*, diagrammatic section through same (after Graber); *G*, auditory apparatus of Caloptenus seen from inner side, showing tympanum, auditory nerve, terminal ganglion, stigma and opening and closing muscle of same, as well as muscle of tympanum membrana (after Graber).—All very greatly enlarged.

and experiment, and draw conclusions from well attested results.

SIGHT.—Taking first the sense of sight, much has been written as to the picture which the compound eye of insects produces upon the brain or upon the nerve centers. Most insects which undergo complete metamorphoses possess in their adolescent states simple eyes or ocelli, and sometimes groups of them of varying size and in varying situations. It is difficult, if not impossible, to demonstrate experimentally their efficiency as organs of sight; the probabilities are that they give but the faintest impressions, but otherwise act as do our own. The fact that they are possessed only by larvæ which are exposed more or less fully to the light, while those larvæ which are endophytous, or otherwise hidden from light, generally lack them, is in itself proof that they perform the ordinary functions of sight, however low in degree. In the imago state the great majority of insects have their simple eyes in addition to the compound eyes. In many cases, however, the former are more or less covered with vestiture, which is another evidence that their function is of a low order, and lends weight to the view that they are useful chiefly for near vision and in dark places. The compound eyes are prominent and adjustable in proportion as they are of service to the species, as witness those of the common House-fly and of the Libellulidæ or Dragon-flies. It is obvious from the structure of these compound eyes that impressions through them must be very different from those received through our own, and, in point of fact, the late experimental researches of Hickson, Plateau, Tocke and Lemmermann, Pankrath, Exner and Viallanes, practically establish the fact that while insects are short-sighted and perceive stationary objects imperfectly, yet their compound eyes are better fitted than the vertebrate eye for apprehending objects set in relief or in motion, and are likewise keenly sensitive to color.

So far as experiments have gone, they show that insects have a keen color sense, though here again their sensations of color are different from those produced upon us. Thus, as Lubbock has shown, ants are very sensitive to the ultra violet rays of the spectrum, which we cannot perceive, though he was led to conclude that to the ant the general aspect of nature is presented in an aspect very different from that in which it appears to us. In reference to bees, the experiments of the same author prove clearly that they have this sense of color highly developed, as indeed might be expected when we consider the part they have played in the development of flowers. While these experiments seem to show that blue is the bees' favorite color, this does not accord with Albert Müller's experience in nature, nor with the general experience of apiarians, who, if asked, would very generally agree that bees show a preference for white flowers.

TOUCH.—The sense of touch is supposed to reside chiefly in the antennæ or feelers, though it requires but the simplest observation to show that with soft-bodied insects the sense resides in any portion of the body, very much as it does in other animals. In short, this is the one sense which, in its manifestations, may be conceded to resemble our own. Yet it is evidently more specialized in the maxillary and labial palpi and the tongue than in the antennæ, in most insects.

TASTE.—Very little can be positively proved as to the sense of taste in insects. Its existence may be confidently predicated from the acute discrimination which most monophagous species exercise in the choice of their food, and its location may be assumed to be the mouth or some of the special trophial organs which have no counterpart among vertebrates. Indeed certain pits in the epipharynx of many mandibulate insects, and, in the ligula and the maxillæ of bees and wasps are conceded, by the authorities, to be gustatory.

SMELL.—That insects possess the power of smell is a matter of common observation, and has been experimentally proved. The many experiments of Lubbock upon ants left no doubt in his mind that the sense of smell is highly developed in them. Indeed it is the acuteness of the sense of smell which attracts many insects so unerringly to given objects, and which has led many persons to believe them sharp-sighted. Moreover, the innumerable glands and special organs for secreting odors, furnish the strongest indirect proof of the same fact. Some of these, of which the osmaterium in Papilionid larvæ and the eversible glands in Parorgyia are conspicuous examples, are intended for protection against inimical insects or other animals; while others, possessed by one only of the sexes, are obivously intended to please or attract. A notable development of this kind is seen in the large gland on the hind legs of the males of some species of Hepialus, the gland being a modification of the tibia, and sometimes involving the abortion of the tarsus, as in the European *H. hectus* L. and our own *H. behrensi* Stretch. The possession of odoriferous glands, in other words, implies the possession of olfactory organs. Yet there is among insects no one specialized olfactory organ as among vertebrates; for while there is conclusive proof that this sense rests in the antennæ with many insects, especially among Lepidoptera, there is good evidence that in some Hymenoptera it is localized in an ampulla at the base of the tongue, while Graber gives reasons for believing that in certain Orthoptera (Blattidæ) it is located in the anal cerci, and the palpi.

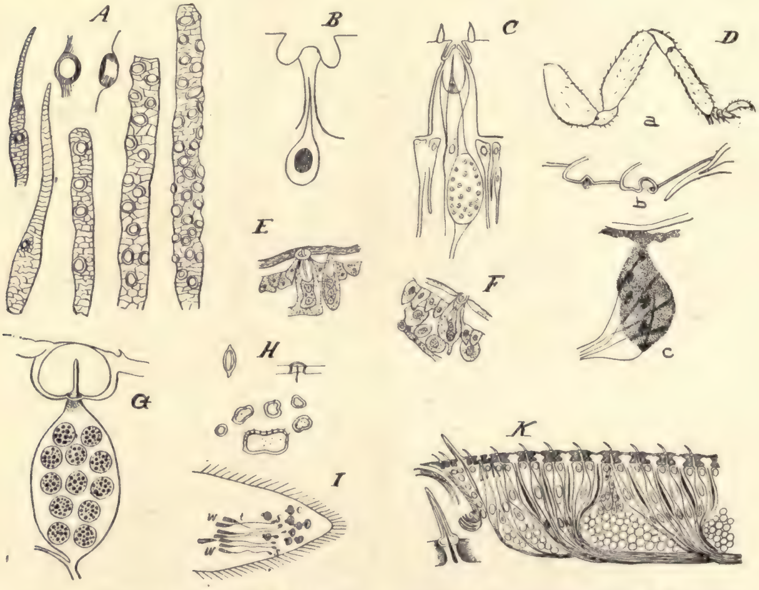

FIG. 9.—SENSORY ORGANS IN INSECTS: *A*, sensory pits on antennæ of young wingless *Aphis persicæ-niger* (after Smith); *B*, organ of smell in May Beetle (after Hauser); *C*, organ of smell in Vespa (after Hauser); *D*, sensory organs of *Termes flavipes*, *a*, tibial auditory organ, *c*, enlargement of same, *b*, sensory pits of tarsus (after Stokes); *E*, organ of taste in maxillæ of *Vespa vulgaris* (after Will); *F*, organ of taste in labium of same insect (after Will); *G*, organ of smell in Caloptenus (after Hauser); *H*, sensory pilose depressions on tibia of Termes (after Stokes); *I*, terminal portion of antennæ of *Myrmica ruginodis*, *c*, cork shaped organs, *s*, outer sac, *t*, tube, *w*, posterior chamber (after Lubbock); *K*, longitudinal section through portion of flagellum of antennæ of worker bee, showing sensory hairs and supposed olfactory organs (after Cheshire).—All very greatly enlarged.

HEARING.—In regard to the sense of hearing the most casual experimentation will show (and general experience confirms it) that most insects, while keenly alive to the slightest movements or vibrations, are for the most part deaf to sounds which affect us. That they have a sense of sound is equally certain, but its range is very different from ours. A sensitive flame arranged for Lubbock by the late Prof. Tyndall, gave no response from ants, and a sensitive microphone arranged for him by Prof. Bell gave record of no other sound than the patter of feet in walking. But the most sensitive tests we can experimentally apply may be, and doubtless are, too gross to adjust themselves to the finer sensibilities of such minute, active and nervous creatures. There can be no question that insects not only produce sounds, but receive the impression of sounds entirely beyond our own range of perception, or as Lubbock puts it, that "we can no more form an idea of than we should have been able to conceive red or green if the human race had been blind. The human ear is sensitive to vibrations reaching at the outside to 38,000 in a second. The sensation of red is produced when 470 millions of millions of vibrations enter the eye in a similar time; but between these two numbers, vibrations produce on us only the sensation of heat. We have no especial organ of sense adapted to them." It is quite certain that ants do make sounds, and the sound-producing organs on

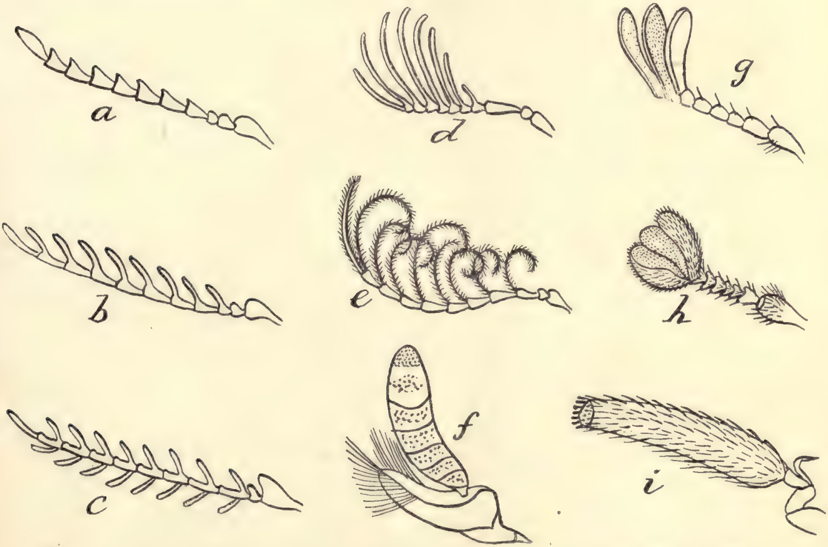

FIG. 10.—SOME ANTENNÆ OF COLEOPTERA: *a*, Ludius; *b*, Corymbites; *c*, Prionocyphon; *d*, Acneus; *e*, Dendroides; *f*, Dineutes; *g*, Lachnosterna; *h*, Bolbocerus; *i*, Adranes, (after LeConte and Horn).—All greatly enlarged.

some of the abdominal joints have been carefully described. The fact that so many insects have the power of producing sounds that are even audible to us, is the best evidence that they possess auditory organs. These are, however, never vocal, but are situated upon various parts of the body or upon different members thereof.

SPECIAL SENSES AND SENSE-ORGANS.—While from what has preceded it is somewhat difficult to compare the more obvious senses possessed by insects with our own, except, perhaps, the sense of touch, it is, I repeat, just as obvious to the careful student of insect life that they possess special senses which it is difficult for us to comprehend. The sense of direction, for instance, is very marked in the social Hymenoptera which we have been considerering, and in this respect insects remind us of many of the lower vertebrates which have this sense much more strongly developed than we have. Indeed, they manifest more especially what has been referred to in man as a sixth sense, viz., a certain intuition which is essentially psychical, and which undoubtedly serves and acts to the advantage of the species as fully, perhaps, as any of the other senses. Lubbock demonstrated that an ant will recognize one of its own colony from among the individuals of another colony of the same species, and when we consider that the members of a colony number at times not thousands but hundreds of thousands, this remarkable power will be fully appreciated.

The neuter Termites are blind and can have no sense of light in their internal or subterranean burrowings; yet they will undermine buildings and pulverize various parts of elaborate furniture without once gnawing through to the surface, and those species which use clay will fill up their burrowings to strengthen the supports of structures which might otherwise fall and injure the insects or betray their work. The bat in a lighted

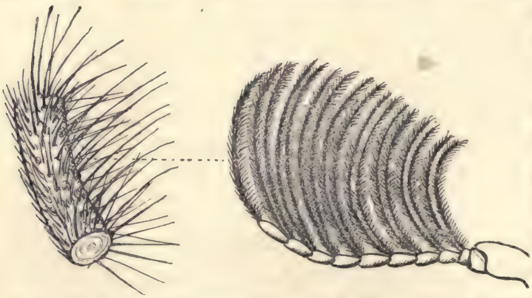

FIG. 11.—Antenna of male Phengodes with portion of ray. —Greatly enlarged. (Original.)

room, though blinded as to sight, will fly in all directions with such swiftness and with such infallible certainty of avoiding concussion or contact, that its *feeling at a distance* is practically incomprehensible to us.

The manner in which anything threatening its welfare thrills and agitates one of these insect communities, and causes every individual to act at once for the common good, has been noted by all observers, and is a good illustration in point. It may be likened to the manner in which the same conditions influence communities of other animals, including man. There are emergencies when intuitive feeling dispossesses reason, and every capable person seems blindly urged to definite action for the protection of the community, regardless of consequence. The war-cry of a nation is an example in point, and violations of otherwise just, but tedious, processes of law, are under certain circumstances deemed justifiable. I shall never forget the emotion that influenced the citizens of Chicago the day following their great fire in 1871. Reason, argument, judgment, were in abeyance. The quicker, intuitive processes prevailed, and to meet lawlessness and the tendency to incendiarism, every right-minded citizen was ready to do vigilant duty, regardless of personal interest, every incendiary being hung to the nearest lamp-post, without ado or delay. It was the universal and deep-seated instinct of self-preservation.

TELEPATHY.—But however difficult it may be to define this intuitive sense which, while apparently combining some of the other senses, has many attributes peculiar to itself, and however difficult it may be for us to analyze the remarkable sense of direction, there can be no doubt that many insects possess the power of communicating at a distance, of which we can form some conception by what is known as telepathy in man. This power would seem to depend neither upon scent nor upon hearing, in the ordinary understanding of these senses, but rather on certain subtle vibrations, as difficult for us to apprehend as is the exact nature of electricity. The fact that man can telegraphically transmit sound almost instantaneously around the globe, and that his very speech may be telephonically transmitted, as quickly as uttered, for thousands of miles, may suggest something of this subtle power, even though it furnish no explanation thereof.

The power of sembling among certain moths, for instance, especially those of the family Bombycidæ, is well known to entomologists, and many remarkable instances are recorded. (Note 7.) I am tempted to put on record, for the first time, an individual experience which very well illustrates this power, as, on a number of occasions when I have narrated it, most persons not familiar with the general facts have deemed it remarkable. In 1863 I obtained from the then Commissioner of Agriculture, Col. Capron, eggs of *Samia cynthia*, the Ailanthus silk worm of Japan, which had been recently introduced by him. I was living on East Madison Street, in Chicago, at the time, a part of the city subsequently swept by the great fire, and since entirely transformed. In the front yard, which (so commonly the case in the old Chicago days) was below the sidewalk, there grew two Ailanthus tress which were the cause of my sending for the aforesaid eggs. I had every reason to believe that there were no other eggs of this species received in any part of the country within hundreds of miles around. It seemed a good opportunity to test this power

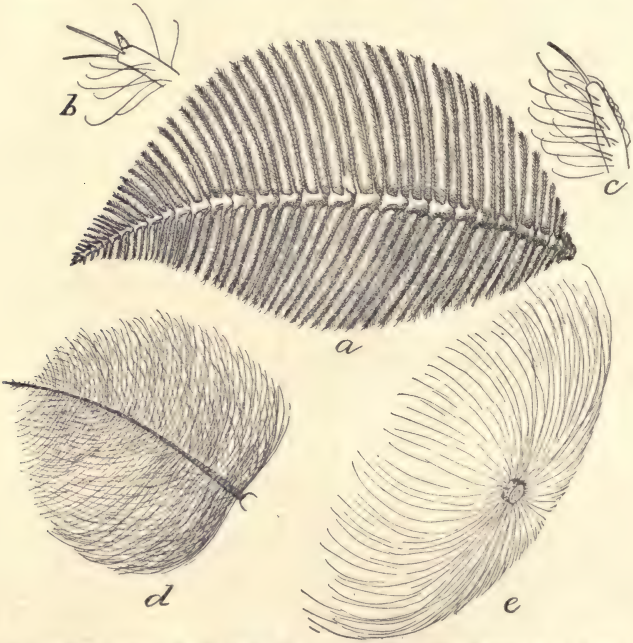

FIG. 12.—SOME ANTENNÆ OF INSECTS: *a*, Telea polyphemus, male, × 3; *b* and *c*, tips of rays of same still more enlarged; *d*, Chironomus × 6; *e*, section of same still more enlarged. (Original.)

of sembling, and after rearing a number of larvæ, I carefully watched for the appearance of the first moths from the cocoons. I kept the first moths separate and confined a virgin female in an improvised wicker cage out of doors on one of the Ailanthus trees. On the same evening I took a male to the old Catholic cemetery on the north side, which is now a part of Lincoln Park, and let him loose, having previously tied a silk thread around the base of the abdomen to insure identification. The distance between the captive female and the released male was at least a mile and a half, and yet the next morning these two individuals were together.

Now in the moths of this family the male antennæ are elaborately pectinate, the pectinations broad and each branch minutely hairy. (See Fig. 12, *a*). These feelers vibrate incessantly, while in the female, in which the feelers are less complex, there is a similar movement connected with an intense vibration of the whole body and of the wings. There is therefore, every reason to believe that the sense is in some way a vibratory sense, as indeed at base is true of all senses, and no one can study the wonderfully diversified structure of the antennæ in insects, especially in males, as very well exemplified in some of the commoner gnats (see Fig. 12, *d*, *e*), without feeling that they have been developed in obedience to, and as a result of, some such subtle and intuitive power as this of telepathy. Every minute ramification of the wonderfully delicate feelers of the male Mosquito, in all probability pulsates in response to the piping sounds which the female is known to produce, and doubtless through considerable distance.

There is every justification for believing that all the subtle cosmic forces involved in the generation and development of the highest, are equally involved in the production and building up of the lowest of organisms, and that the complexing and compounding and specialization of parts have gone on in every possible and conceivable direction according to the species. The highly developed and delicate antennæ in the male Chironomus, for instance, may be likened to an external brain, its ramifying fibers corresponding to the highly complicated processes that ramify from the nerve cells in the internal brains of higher animals, and responding in a somewhat similar way to external impressions. While having no sort of sympathy with the foolish notions that the spiritists proclaim, to edify or terrify the gullible and unscientific, I am just as much out of sympathy with that class of materialistic scientists who refuse to recognize that there may be and are subtle psychical phenomena beyond the reach of present experimental methods. The one class too readily assumes supernatural power to explain abnormal phenomena; the other denies the abnormal because it likewise is past our limited understanding. "Even now," says William Crookes, who speaks with authority, "telegraphing without wires is possible within a radius of a few hundred yards," and, in a most interesting contribution to our present knowledge of vibratory motion and the possibilities of electricity, the same writer remarks:*

> "The discovery of a receiver sensitive to one set of wave lengths and silent to others is even now partially accomplished. The human eye is an instance supplied by nature of one which responds to the narrow range of electro-magnetic impulses between the three ten-millionths of a millimeter and the eight ten-millionths of a millimeter. It is not improbable that other sentient beings have organs of sense which do not respond to some or to any of the rays to which our eyes are sensitive, but are able to appreciate other vibrations to which we are blind. Such beings would practically be living in a different world from our own. Imagine, for instance, what idea we should form of surrounding objects were we endowed with eyes not sensitive to the ordinary rays of light, but sensitive to the vibrations concerned in electric and magnetic phenomena. Glass and crystal would be among the most opaque of bodies. Metals would be more or less transparent, and a telegraph wire through the air would look like a long narrow hole drilled through an impervious solid body. A dynamo in active work would resemble a conflagration, while a permanent magnet would realize the dreams of mediæval mystics and become an everlasting lamp with no expenditure of energy or consumption of fuel.
>
> In some parts of the human brain may lurk an organ capable of transmitting and receiving other electrical rays of wave lengths hitherto undetected by instrumental means. These may be instrumental in transmitting thought from one brain to another." * * *

INTELLIGENCE IN INSECTS.

Anyone who has closely studied the ways of insects, especially as exemplified in the social species we have been considering, will not doubt that they possess intelligence. They communicate with each other by a language, which, though unspoken, is no less eloquent of all their wishes and desires. They work for the common good; they train a soldier and a police force; they are brave in the defense of the communal interest; they protect and defend their sovereign; they make war and even organize military expeditions; they make slaves and are held in bondage; they encourage and protect other insects which yield them cherished nourishment; they even go so far as to care for the eggs of such, and thus deliberately rear their nectar-giving kine; they cultivate crops; they providently store food for winter use or in anticipation of an inauspicious season; they give expression to satisfaction and pleasure; they exhibit certain baser passions, as jealousy, ill-temper or rage; they even display a certain moral sense, and will help, on occasions, the distressed and threatened of their own kind; they are most assiduous in the care and rearing of their young; they profit by experience; they manifest a pure and simple enjoyment of life by their gambols and playfulness; they are cleanly to a degree which will astonish those who for the first time observe their constant licking and brushing of all parts of the body; they exhibit, in short, most of the sense manifestations displayed by higher animals. It may be ingeniously argued that in all these manifestations they are acting as mere automatons, but the same arguments may be, and have been, urged to explain the actions of man.

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* "Some possibilities of electricity." *Fortnightly Review*, March, 1892.

So far as experimentation goes, and especially that by Sir John Lubbock, bees are not gifted with the high degree of intelligence with which many writers have credited them, and in this respect do not compare with the higher ants. The Termites are probably the lowest, bees next, wasps next, and ants the highest, in point of intelligence, among social insects. The affection of the bees for their queen, or the deference paid by ants, wasps and Termites to theirs, may be viewed as an instinctive expression of their communal obligation to her, which is at once transferred to another by whom she may be replaced; but our own fealty to our rulers may bear very much the same interpretation. Wasps are more alert and intelligent than bees, and as Lubbock has shown, are measurably susceptible of being tamed. Ants, as we have seen, exhibit a very high degree of intelligence. In fact, the manner in which all these insects work together in harmony, and especially the manner in which certain individuals act as scouts or deliberately set to work to remedy and overcome any exceptional interference with or injury to their habitations, denotes considerable reasoning and reflective power; while the anticipation of the needs of the community—as in the building of queen cells at the proper time by bees and wasps, the varying treatment of the young, and the preparation for swarming by all the social insects—argues an intuitive perception which is as conscious as that which higher animals display in making similar provision for their progeny. This very intuition is the origin of intellect, or, rather, the primary form of intellect. It is, as Ward expresses it, older than reason, and parent of the later faculties of abstraction and reflection. It involves all that we know as sagacity and cunning, displayed by animals for their own good.

But it is to the nature of this intelligence that I would call your attention, since many may question the use of the term in connection with these insects. It has been the fashion in the past to separate man from the rest of the animal world by the nature of his intelligence. The earliest philosophers, instead of beginning with the simpler problems of subjective nature, seem to have been fascinated by the more complex phenomena of objective nature. They built up a fabric of metaphysics which modern methods of induction and modern experimental physiology and psychology have demolished and remodeled. We have had dissertations on the will as something quite independent of the body, and speculations as to the difference between human and divine will.

We must certainly grant to insects the sensations of pleasure and pain, for the worthiest authorities now concede that the least of sentient beings—or animals as contra-distinguished from plants—must possess feeling, however faint. Feeling means either pleasure or pain, the former the inevitable out-growth of experience favorable to the organism, the latter the converse. The former is a sign post on the road to all that is good for the race, the latter a warning of all that is evil; though, paradoxical as it may seem, this is just as necessary to the welfare of the organism. What is evil for the individual may be good for the race. Now all feeling must be conscious, and the different grades of consciousness of feeling, until we reach self-consciousness, involving intellectual processes, are but gradations in the manifestations of one and the same kind of force. Indeed, it is now conceded by advanced thinkers of the biologic school that intellect had its origin in and depends on the senses, and that mind is divisible into feeling and understanding. Most of the acts of these social insects are, it is true, what we call instinctive*; but as I have so often had occasion to express my views and the reasons for them, on the subject of instinct, it is unnecessary to enlarge upon them further than to state that the instinctive acts of insects are often combined, in a greater or less degree, with a low order of conscious reasoning, and that while this is generally of the intuitive kind, it is, on occasions, deliberate and reflecting.

> "If in the insect Reason's twilight ray
> Sheds on the darkling mind a doubtful day,
> Plain is the steady light her Instincts yield,
> To point the road o'er life's unvaried field;
> If few those instincts, to the destined goal,
> With surer course, their straiten'd currents roll."—Evans.

Two beliefs that have very generally prevailed among men up

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*Romanes considers that the instincts of neuter insects are themselves sufficient to refute Lewes' theory of instinct as being lapsed intelligence transmitted through heredity; and he criticises Spencer's views that "the automatic actions of a bee building one of its wax cells answer to outer relations so constantly experienced that they are, as it were, organically remembered." He bases his criticism upon the statement that the bee "begins by performing these actions before it has itself had any individual experience of cell-making and without its parents ever having had any ancestral experience." While this statement represents accepted belief, it follows from what I have already said of the bee that it is essentially untrue. The worker could no more begin to secrete wax and build cells until it had acquired a certain age than could mammals secret the lacteal fluid before a certain age; and during its early life as an adult it had the experience of its older fellows to guide it, were such guidance necessary. The example chosen by Romanes was simply unfortunate. To understand the development of the cell-building instinct, we must consider the stages of its development as illustrated in the varying forms of cells yet existing, from the cruder cells of Bombus on, and remember that each step in the more perfect building has been accompanied by structural modifications, and that the instincts have been accumulated and perfected by heredity *pari passu* with the structures; further that the habit probably became so firmly fixed before the neuters had been differentiated, that it has been transmitted since that time through the queen, though she herself no longer possesses it; further that while instinctive performance is ordinarily inevitable, it yet varies in the amount of its fixity and accuracy and often leads astray or fails; and, finally, that it is often modified by individual experience or reason, or by communal interest or necessity—these truths applying particularly to the social insects, and in a variable degree to all animals.

to within recent years, have been so effectually discarded that they are even renounced by the more advanced theologians. I refer to the belief that organisms were specially created as they now exist, and that man was apart from, and not a part of, the rest of the animal world. It is my judgment that a third equally prevalent notion is essentially false, and will have to be abandoned before we can properly appreciate the psychology of animals. I refer to the notion that the lower animals do not reason, and are incapable of conscious reflection and thought. It would be easy to occupy your time for hours with accounts of their actions which can be explained only upon the views here set forth, and which are utterly at variance with the popular notions and prejudices.

The insects to which I have referred to-night are admitted to be among the more intelligent of their class; but they are only illustrations of an intelligence which is found throughout the other orders, and which impresses us in proportion as we study it and come to realize and recognize it. We can never properly appreciate, nor properly bring ourselves into sympathy with these lower creatures, until we recognize that they are actuated by the same kind of intelligence as we ourselves. There are certain acts which all creatures necessarily perform, as an outgrowth of their organization. These are essentially the instinctive acts, and are, for the most part, inevitable and often unconscious. A great many of the acts of rational men are, in this view, instinctive, and from birth to maturity many of them are prompted solely by the consecutive development of different parts of the organization, and are much less the result of training and teaching than is generally believed. Most of the acts of insects are instinctive and explicable upon this same view, but no one can study them carefully and without bias and not feel that these instinctive and inevitable actions are associated with many others which result from the possession of intelligence—of conscious reasoning and reflective powers. In this view of the case is the whole world truly kin, and is man brought more fully into sympathy with and appreciation of it.

Is it not significant also, that, just as in man, among mammalia, the higher intellectual development and social organization is found correlated with the longest period of dependent infancy; that this helpless infancy has been, in fact, as Fiske has shown, a prime influence in the origin, through family, clan, tribe and state, of organized civilization; so in the insect world we find the same correlation between the highest intelligence and dependent infancy, and are justified in concluding that the latter is, in the social Hymenoptera as in man, in the same way the cause of the high organization, and division of labor so charateristic of them!

HEREDITY: NATURAL SELECTION.

The application of the principle of natural selection to the production of neuter insects, and especially to the production of neuter insects of diversified form, seems, at first sight, impossible. Indeed, we know that Darwin felt that this question of neuter insects was one of the most difficult to deal with in connection with his grand generalization. Weismann, who believes in the all-sufficiency of natural selection, insists, and has within the past year, in his controversies with Herbert Spencer, emphasized his belief, that these neuter insects absolutely preclude the idea of the transmission of acquired characters, and endeavors to explain their occurance by his own peculiar theories as to modification taking place in the germ plasm. I shall certainly not attempt, in the limited time that I may yet hope to hold your attention, to discuss in detail the views held whether by Weismann or his opponents;* but I will venture to show that, while the social insects offer the most serious obstacles to the acceptance of the theory of natural selection as an all-sufficient theory to explain the phenomena. yet the facts are perfectly explicable upon the general principles that have governed the modification of organisms, among which that of natural selection plays an important, but limited part.

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*The chief argument in favor of Weismann's theory of heredity is that it is an earnest attempt to establish a basis in observed histologic and embryologic facts. The idea of the continuity or "immortality" (using the word in his own qualified use of it) of the germ plasm is a bold one which gives us at least a conceivable and material basis of reproduction, and is justified, though not absolutely, in the facts referred to and in the history of the Protozoa. One of the chief arguments against it is, in my judgment, that, inasmuch as it precludes the transmission of impressions on the soma, i. e., individually acquired characters, Weismann has, in order to sustain the theory, been led to question and finally to deny the transmissibility of such acquired characters. It is difficult to formulate the later modifications of the original theory without using many Weismannisms, themselves requiring chapters of explanation; but that variation is due to direct effects on the germ plasm by inequalities of nutrition, is, I believe, a correct statement of his latest views. The trouble with all theories of reproduction and heredity based solely on observed microscopic facts, is that the essence, the life principle, the potential factors, must always escape such methods. Wherefore any theory that will hold must cover the psychical as well as the physical facts —the total of well established experience—and this truth was doubtless

In the economy of the Hive Bee we have seen that all the neuters are structurally alike, and that the different functions which they perform result from inherited tendencies or structural peculiarities developed at different ages. There are some records of abnormal workers, small drones, and slight variations in the amount of arrestation of development; but on the whole the three classes of queen, worker and drone are remarkably well differentiated and fixed. We have seen that the differences in the two former classes result from conditions of food, treatment and environment of the young, and are under the control of the colony. Each fertile egg has the potentiality of developing a fertile queen, and as the neuters, under exceptional conditions, are able to lay eggs which invariably produce drones, the queen, through such drones, must occasionally inherit indirectly from the workers. At bottom, however, the differentiation between the workers and the queen is purely a matter of food and bringing up, or *education*, as the French would more correctly call it. In other words, the ultimate result is decided for each generation in the treatment of the young or the larvæ. The drone results from an unfertilized egg, and as the egg is only fertilized when the tip of the queen's abdomen is pressed into a worker cell, and not when thrust into a drone cell, the production of drones is also under control of the colony.

I have already called attention to the fact that other species

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recognized by Darwin in framing his tentative theory of pangenesis.

Weismann's efforts to derive a physical theory of reproduction and evolution find a paralell in the efforts of those entomological histologists who, starting with the conception that the development of the individual was but an unfolding of structures already nascent in the embryo, expected to find—and even claim to have found—all the structures of the imago represented, *en petit*, in the larva. In truth, however, there is a total re-adjustment of cells, and development *de novo* of organs, with each important change or molt, and the vital force which impels this development, whether of the minutest bodily structure or the subtlest intellectual attribute, is the great mystery beyond explanation.

of bees show gradations in these two kinds of females, and that some species permit more than one queen or fertile female in the colony and would refer for further details, both as to present gradations and variations to the Notes, especially numbers 1, 2, 3, and 4. Natural selection, if it has played any part at all, must have done so chiefly in the manner ingeniously suggested by Darwin himself, namely, not as between individuals, but as between colonies. The tendency to produce arrested females or neuters doubtless became fixed in some ancestral form through social selection, and is kept up by this and colony selection.

In the wasps we have a very different state of things, involving the parthenogenetic production of arrested females and the seasonal production of fully developed forms of both sexes. Here again, the evidence all goes to show that the differences depend for each generation on the environment, food and method of nurture of the larva, the tendency having become fixed in varying degrees in the different species, and only so fixed by being transmitted through the queen or sexually perfect females. So far as natural selection has acted at all, it has acted on the potentiality or inherited tendencies of these females. Very exact information is not yet at hand as to how far the neuters are variable, whether as to condition of the reproductive organs or as to size. But judging merely by mounted specimens which I have examined in various species, it is probable that there is some variation in these respects, though the three classes are quite neatly differentiated, much as in the bees.

When it comes to the ants, the problem is more complicated; but we may safely assume that the different forms have been brought about by the same influences. In a large colony of individuals, where size and character are not fixed by a definite cradle, but where the young larvæ are free and are carried about, nursed and fed by the workers, there would naturally arise greater variations between individuals, and while the kind of nourishment, or the kind of nurture, or the age of the female at the time the ova are produced, or the season of the year, have doubtless all contributed to the variation, and may still independently contribute to it at the present time; yet, whatever the causes of this variation, it has become fixed in certain definite lines that are more or less useful to the species. Whether or not the proportion of the different individuals is under the control of the colony as a whole, by virtue of the treatment of the larva, it will always be difficult to prove, though there is every reason to believe that, as in the bees, there is, to some extent, such control, and that the relative proportions of the different forms will depend upon circumstances. But the fact remains that, in ants, as in bees and wasps, the neuters are but arrested females, and are capable of becoming, under exceptional circumstances, fertile, and that we see in the different species all gradations, not only as to the number of forms of the workers, but as to the number of fertile females that are allowed in the same colony to provide for the continuance of the species. We also find in the same species great variation and gradation in the characters of the different sets which form the community, especially between the different forms of workers, in contrast to what I have remarked as to bees and wasps. This has been recorded not only by writers like Darwin and Lubbock, but by all who have given close attention to the subject; while Ch. Lespès (*Ann. des Sciences Nat.* (4) 20, pp. 241–251) in his "Observations sur les Fourmis Neutres" has shown that all neuters have traces of the female reproductive organs; that these traces vary in the different species; and that where there are two forms of neuters these pass insensibly into each other through intermediate forms. The ants thus furnish us with varying degrees of social organization when the different species are considered, while the different classes in the same species are not as definitely fixed as in the bees or the wasps.

Now it were comparatively easy to account for these neuters among the social Hymenoptera and the different forms and attributes which they present, by putting aside natural selection, as expounded by Darwin, and substituting therefor social selection acting not on generations in time, but on the individual at once by the manner of its bringing up; and surely there would seem to be sufficient justification for this course when we find not only such great physiological and functional, but such profound structural modifications induced by larval environment and nurture, as I have pointed out, especially between the queen and the worker bee.* This has, in fact, been the chief explanation which

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*Mr. Herbert Spencer, in one of his rejoiners to Prof. Weismann, (*Contemporary Review*, December, 1893) refers to a chapter on The Determination of Sex by Prof. Geddes and Mr. Thompson in their "Evolution of Sex," I have offered for the facts, in discussions with friends and before the society, limiting the action of natural selection to colonies as a whole. Few persons who have not had large experience in rearing insects can appreciate the full influence of larval environment and food on the ultimate imago, or the power of larval accomodation to various conditions. All insects in the larva state possess this power, within varying limits, and it is nowhere more marked than in the Aculeate Hymenoptera. I have called attention to it on numerous occasions* when treating of parasitic species, and it is particularly noticeable in the fossorial Hymenoptera and the Meloïdæ. Size, especially, may easily be dimin-

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where they state that "such conditions as deficient or abnormal food" and others "causing preponderances of waste over repair * * * tend to result in the production of males," while "abundant and rich nutrition" and other conditions which "favor constructive processes * * * result in the production of females." He then cites J. H. Fabre's statement that in the nests of *Osmia tricornis* the eggs at the bottom of the cell which are first laid and accompanied by much food, produce females, while those at the top, laid last and accompanied by one-half or one-third the quantity of food, produce males. (Souvenirs Entomologiques, 3ème série, page 328). He further refers to Hüber's observations, that the queen bee only lays eggs of drones when declining nutrition or exhaustion has set in, and that when the workers in bees and wasps lay eggs, these produce drones.

These statements are not entirely justified. I cannot speak positively of Fabre's observations, though I suspect something back of the larval food-supply which has fixed the sex and determined the treatment of the larva. But the queen bee produces drones at any age by the egg passing into the drone cell and not being impregnated in passing the spermotheca. She produces drones only when she is superannuated, because the spermatozoa have become exhausted. In wasps it is just the contrary, the unimpregnated egg producing ordinarily, not a drone or a male, but a female. I have already called attention to the ease with which erroneous conclusions are drawn in this matter of regulating sex by food of larvæ, *ex ovo* (Am. Naturalist, Vol. VII, pp. 513–531, September, 1873) and the evidence would seem to how that the influence is confined to arrestation or modification of the sex without changing it. The subject is, however, most intricate, and further experimental facts are needed. Spencer's conclusion is, nevertheless, generally true, namely: "*that one set of differences in structure and instincts is determined by nutrition before the egg is laid, and a further set of differences in structure and instincts is determined by nutrition after the egg is laid.*"

*See notes on *Tiphia inornata*, Sixth Report on the Insects of Missouri, p. 123, and upon Blister-beetles, First Report U. S. Entomological Commission, pp. 295–302, ished one-half or more, or fully doubled, from the normal, by limiting or increasing the supply of food, as I have proved with Pelopaeus.

But when we come to the facts in the economy of the Termites, this explanation does not hold good to the same degree. Here we find still greater diversity in form than even among ants, under circumstances where control of these forms by the colony itself must be much less, but nevertheless does occur. The young Termite is to a limited extent, and during early life only, provided with food by members of the colony, and from birth is essentially a free moving agent, less dependent on the adults. We have much yet to learn as to the actual facts, which would seem also to vary in different species. Thus in Eutermes Mr. Hubbard believes, but I think wrongfully, that the young feed on nodules, specially prepared, of comminuted and doubtless partly digested material, while Fritz Müller believes that they feed on a fungus mycelium which develops on such prepared substance. The truth with most species seems to be that they are fed on a semi-liquid fluid disgorged from the mouth, whether of the workers or the undeveloped queens; while in some cases they are fed from a secretion from the anus. (See Note 6.) In these respects and in the early helplessness of the larvæ, they closely approximate the social Hymenoptera.

Similar variations to those found in social insects, whether sexual or seasonal, are extremely common among insects which are not social, as is well exemplified by the long category of phytophagic variation, secondary sexual characters, and of dimorphism and heteromorphism among insects. These variations in non-social insects are often equally as marked and as curious, structurally, as they are among social species. They are also, except, perhaps, the secondary sexual characters and the variations which take on the form of mimicry, equally difficult to explain on any view of natural selection that is all-sufficient. On the whole, then, it may safely be said that the production of neuter insects is determined in each generation by the colony itself, in the manner in which the larvæ are fed and reared. In so far as this is true, it is outside the domain of natural selection, and speaks eloquently in favor of the various other causes of variation and modification which have been insisted upon by many of our leading American biologists, and which I have repeatedly urged in my own writings.* The tendency to such production was doubtless developed in the ancestors of the present species, and we may even trace the steps by studying the gradations in existing species.

The facts connected with the social insects which I have considered, present the strongest argument in favor of the heredity of acquired characters and tendencies. Competition has been between colonies rather than individuals, and those colonies which have acquired, through heredity, the habit of producing, through one or more fertile females, the different forms which have proved useful in the social economy, have, in the course of time, survived others in which such tendency was less pronounced. Yet various steps in the process are yet manifest in the different species, and under these circumstances it seems to me foolish to insist that the fixed habit in one species has, *per se*, any especial advantage over the less fixed habit in others which still maintain themselves. I need hardly say to the members of this Society who are familiar with my views as to the causes of variation, that it does not follow in my mind that the different forms of Termites, for instance, that are found in the colonies of some species, are all essential, but that some of the forms may be advantageous, others only partially so, and still others purely fortuitous. The tendency to vary—an inherent property in all organisms—has shown itself among the individuals of these different colonies. These variations have been guided by natural selection among colonies, and by what I have just referred to as social selection among individuals, along certain lines which are most useful. In other cases the variation has accumulated along lines of secondary utility; while in yet others it has gone along lines which are purely fortuitous and still most variable and unfixed—natural selection playing little or no part in these. In species with the less complete social organization, the existing variations will be greatest; while the structures and functions have become most fixed and show least tendency to vary in those species which have become most specialized and perfect in their social economy. It is very questionable, however, whether, in the struggle for existence, this greater specialization and fixity give the species any advantage over another which is more elastic and variable. On the contrary there are many facts which go to show that extreme specialization is a disadvantage and the precursor of decrease and ultimate extinction. So that natural selection, in this light, if limited, as its exponents have limited it, to the production of characters absolutely essential or useful to the species, must play a yet more restricted part in organic variation than even I have allotted to it. Social selection, as here expounded, implies, it is true, a degree of intelligence which has unusually been denied these creatures; but the phenomena are some of them inexplicable upon any other theory, and I have, I hope, already shown how little reason we have for denying them such intelligence.

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*See more particularly the address before Section F, at the Cleveland (1888) meeting of the A. A. A. S , and the paper before this Society "On the Interrelations of Plants and Insects," Vol. VII, pp. 81–104 (May, 1892).

In a certain way the production of these specialized individuals in a colony of insects may be likened to the production of specialized individuals in a human community. In new countries, like our own, the specialization has not become so marked, but in the older communities of the world, the life of the individual, and especially the early training and environment, produce certain characteristics which permit us to stamp at once the typical sailor, soldier or butcher, the various artisans and the men of various professions. They undergo essential modifications in mind and body. Yet there is no question—or very little—of selection, whether natural or artificial. The tendency to vary in given directions becomes fixed through heredity, since the characteristics of different nationalities in comparison with each other cannot be so well explained upon any other view. Certain types persist, and the same laws which will explain the recurrence and persistence in a promiscuous community of, say, the red-headed type, whether that of atavism or any other be adduced, will undoubtedly apply to the persistency of types in the social insects. That no material or mosaic theory of heredity yet propounded is satisfactory, as accounting for the facts, does not affect the question, and that natural selection, as expounded by Weismann and the ultra-Darwinians, fails to explain the phenomena, is the very best evidence that too much is claimed for the theory.

INVERTEBRATE VS. VERTEBRATE.

I used to be fond of speculating as to the possibilities of the articulate type as exemplified in the ant, in comparison with the vertebrate type as exemplified in man, had the former continued its development so as to approximate, say, the eagle in bodily size and man in brain development. That the Arthropod type could attain to such dimensions is evidenced in the Eurypterus or water scorpion which prevailed in early geologic times, and attained a length of six feet; while a modern Japanese crab (*Megachilus kæmpferi*) has a spread of ten or twelve feet, and is a formidable creature.

For very much the same selfish reasons that begot most of our earlier notions as to man's origin and place, it has been assumed that he represents the perfection of the animal organization, the highest expression of an all-wise Creator. Following this same idea, our own world, it has been reasoned, is the only one peopled. Now it has never seemed to me that there was any justification for the assumption that existing forms of plants or animals must of necessity have assumed the physical or mental characteristics which belong to them, considering the myriad forms which have preceded us and gone, or the many which are yet with us, but fast going. Remembering, also, that the race is not always to the swift, nor the battle to the strong, there would seem to be no valid reason why, on some other sphere, under like, or even under unlike conditions, life may not have taken on other distinctive types or attained developments inconceivable to us; or, for that matter, why it might not have been differently manifested upon our own little earth.

Place the directing enginery of the human brain in a body with a hard, external skeleton, which should at once be a defensive armor against exterior attack, a protection to all the vital organs, and yet allow free play to every possible movement; with a breathing system that is multiple, and therefore less liable to get out of order than where it is concentrated in one place; with six or more legs; extremities variously differentiated, so as to enable one pair of them to perform the functions of our hands, while other pairs possessed greater prehensile, tactile or other specialized powers; with powerful primary and with supplemental jaws; with all the senses and sense organs we possess and others added; with simple and compound or telescopic eyes combined in the same individual; with a venomous, offensive and defensive weapon; with a social organization in which working, fighting and reproductive elements are well differentiated and yet under control; with the power of aërial flight developed when wanted; with a reproductive system that permits of great prolificacy and yet avoids all the dangers of placental birth; with the power of temporarily suspending the active life functions when necessary; and, finally, with the power of such renewal of both the softer and harder tissues of the body as ecdysis involves—and you have in fancy a creature which would easily make the earth and all the fullness thereof its own.

The great industry exhibited by social insects has been a favorite topic wherewith to point a moral to the sluggard; but I venture to suggest that their economies, if they do not point other morals, are extremely suggestive to man. With all their other traits, so comparable to those characteristic of human society, they will hardly be charged with the possession or practice of any theology; yet we may look in vain, among all the nations of the earth, unless, indeed, among the similarly unblessed aborigines of Borneo and some other lands, for greater self-sacrifice or courage in defending the common weal; for greater loyalty to the sovereign head of the community, not made by divine right, but practically chosen by the commoners; for greater attention or care in the education of the helpless young, or for more harmonious or friendly action between the individuals that form the community. Without form or ceremony they have developed an altruism which with us is believed to exemplify the highest phase of civilization.

Nor am I quite sure that they have not solved the social problem in a way that, so far as the good of the community as well as the individual is concerned, has marked advantages over the many varied attempts in the same direction by mankind in different parts of the world. If a large proportion of the units of both sexes which go to make up human society could be so brought up and trained that the sexual instincts remained permanently arrested and undeveloped, while along with this arrestation in this particular there went an increasing intellectual development and energy, to be expended in profitable industry, what a large share of vice and misery in human society might be avoided, and what a large amount of increased happiness among the multitude might thus be secured, since in the end, intellectual and bodily activities, freed as far as possible from all baser passions, bring us the highest happiness that we can realize!

APPENDIX.

NOTE 1.—The principal Races of Apis mellifica.

The common form of this species, known as the Brown, the Black or the *German* bee, is the best-known. It is found throughout northern Europe, and as far south as central Austria, central Switzerland, and southern France to the Italian frontier. It also occurs in Portugal and Spain, and extends into Siberia, and, during later centuries, has been introduced into North and South America, many of the Pacific islands, and into Australia.

Its chief merits are that it has a moderate swarming propensity and is an excellent comb-builder and honey gatherer, and accommodates itself to the greatest extremes of climate. Its disadvantages, as compared with some other varieties, are a disposition to rob, to attack persons who approach the hive and to be somewhat less industrious. The general color is a dull brown, lighter on the thorax, the queens nearly black.

The *Heath* and *Brabant* bees, sub-varieties, occuring in the heath districts of northern Germany, are much given to swarming, a habit which has become fixed by the stimulative feeding in spring practised by the bee-keepers there for at least two hundred years.

The *Italian* or *Ligurian* bee, originally confined to Italy, Sicily, Sardinia, the southern Tyrol, and southern Switzerland, has now been introduced into most countries where the common black bee occurs. It is gentler in disposition, but not so good a comb-builder and, with a more tender constitution, does not thrive in extreme northern climates.

The color of the Italians is in general much brighter, and the first three segments of the abdomen are golden-yellow on their dorsal surfaces. Its qualities and its color have become fairly well fixed by artificial selection which there is every reason to believe has been practised in Italy for some two thousand years. Both Virgil and Columella evidently refer to it, the former (Georgics IV, 98) speaking of two kinds of bees, the better of which he describes as having shining bodies, variegated like drops of gold. The tendency to vary under domestication at the present time would indicate that the the race is a composite one, and Mr. Frank Benton informs me that by crossing the Egyptian, the Palestine or the Syrian with the common brown German race, workers are produced in a few generations that can scarcely be distinguished from Italians; a fact which as regards the Egyptains, was ascertained by the Berlin Acclimatization Society which, some 30 years ago, experimented with the honey bees native to Egypt, and which Mr. Benton has since confirmed by tests with the other two races (Palestine and Syrian). He finds also, that the Syrian tpye leads, when crossed with the common brown race, most commonly to the Italian type, a fact which is significant when we remember that the Phœnicians—ancient inhabitants of Syria—established colonies in southern Italy at a very early date. We can hardly realize to-day the importance that was attached to the production of honey and wax in Egypt and the surrounding countries in those days, until we remember the uses to which these articles were put in connection with the religious rites of the people, and especially the embalming of the dead, as well as the relative importance of honey in those early days in the absence of the many other sweets which we possess. In the United States the Italian race, by selection since its introduction a third of a century ago,* has undergone more rapid modification than any of the other races, though greater efforts, proportionately, have been made with these—another fact which would indicate that the Italian type is less fixed than some of the oriental races.

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*See a paper by the author on "What the Department of Agriculture has done for Apiculture." Proc. North American Bee Keepers' Association, 1893.

The *Carniolan* race is confined to Carniola, Austria, and the adjoining provinces, and is a local type developed by some centuries of peculiar treatment with little intermixture of outside blood. This race is somewhat larger than the others, exceedingly robust, the distinctive color-mark being light gray varying to steel blue, the abdominal segments being all edged with pubescence of this color and the thorax thickly set with the same. The race is characterized by great prolificacy, which can be traced to the constant stimulative feeding early in the season, and by a very mild disposition, a result which would seem to be due to the frequent manipulation of the hives, migratory bee-keeping having been practised for centuries in Carniola.

The *Cecropian*, *Attic*, or *Hymettus* bees of Greece, on the other hand, though similar to the Carniolan race in markings, are exceedingly irritable, as a result, doubtless, of their being very little manipulated or interferred with.

The *Tunisian* bees are found in Tripoli, Tunis, and Algeria, where they are extensively cultivated by the natives. The type is uniformly dark in color. The queens are very prolific and when preparing to swarm 200 to 300 queen-cells are often constructed, instead of only 8 to 10 as is usual with the ordinary race. The workers are small, very active, irritable and vindictive. Because of this and the fact that they do not winter well, in consequence of prolonging the brood season, their introduction has been very limited.

The *Egyptians*, or the bees found all over northeastern Africa, and which for several thousand years have been extensively cultivated in Egypt, possess very marked characteristics as regards color, form and habits, and have been regarded by many as worthy of specific rank, having been described by Latreille as *Apis fasciata*. The workers are small-bodied, slender, covered with a dense, light gray pubescence, and the abdominal segments are edged on their dorsal surfaces with a lemon-yellow color, giving with the gray pubescense a banded effect. They do not withstand our winters and are easily angered by manipulation, not being amenable to smoke like European bees. The queens are prolific and when the colonies are made queenless great numbers of workers commence depositing eggs at once.

The *Palestines* and *Syrians* possess many of the qualities and characteristics of Egyptians; yet the queens, workers and drones are readily distinguishable from those of the latter, being less yellow and larger bodied, especially the Syrians. They are marked varieties, more fixed than the Italian, and evidently forming, with other eastern Mediterranean bees, an Oriental group having allied characteristics and of which the Egyptian is the extreme type.

The *Caucasian* and *Smyrnian* races vary more than the other Oriental races. In specimens from Smyrna the light yellow coloration of the abdominal segments noted farther south is found to be replaced by a darker yellow and the light gray pubescence by a less dense and darker gray, often brownish, pubescence. Queens, workers and drones are larger bodied and variations in temper and habit may also be noted.

The *Cyprian* race, having been isolated for a long period, is, as might be expected, a very fixed one—the most thoroughly so of any race of bees yet brought to this country, and transmits its peculiar markings and characteristics through many generations of crosses with any other known type. In general it resembles the race found on the adjacent mainland, whence it was probably brought by the early Phœnicians who colonized Cyprus. Very characteristic markings of this variety are the bright yellow lunule which the postscutellum shows and the bright yellow of the ventral surface of the abdomen clear to the tip. The conditions under which this race has been established have resulted in the survival of a hardy, active race, capable of procuring a living and storing a surplus where others could barely subsist.

The literature refers almost entirely to the older countries of Europe and the East. Some modification has doubtless taken place in the tropical parts of America but the subject has not yet been sufficiently studied in those countries.

NOTE 2.—The Species of Apis with their Varieties.

(1) *Apis mellifica*, L. as indicated in Note 1, is found in all the countries of Europe, and extends over the whole of Asia Minor into the Syrian Desert and south into Arabia. It occupies all the islands of the Mediterranean and has spread through all the northern countries of Africa southward into the Desert of Sahara. South Africa has one or two varieties belonging to the species, while the representatives of the genus found in Senegal and the Congo country doubtless belong to this species, as do those of Madagascar. It has been permanently introduced into Australia, Tasmania, New Zealand and many of the islands of the Pacific ocean. Whether the honey bees reported from northern India belong to this species or not, has not been definitely ascertained. It is also more than probable that the honey bee of China, described under the name of *Apis sinensis*, is but a variety of this species. In North and South America it is evidently introduced, and has spread into some of the adjacent islands. There is a difference of opinion as to whether the honey bee native to Egypt, which Latreille describes as *Apis fasciata*, should have specific rank or be regarded as a variety of *mellifica*. While Frederick Smith, who was one of our best authorities, was inclined to attribute to it specific value, the fact that it interbreeds with *mellifica*, producing fertile offspring, would rather confirm the opposite view. Respecting the honey bees of Tasmania, Senegal, the Congo and Madagascar, our information is insufficient to permit us to say whether they are specifically distinct or not, and the same may be said of the Hazara, Bhootan, and Bushar bees of northern India and other more or less distinct types found in Japan.

(2) *Apis indica* Fabr. The extent of territory occupied by this small East Indian bee is not definitely known, although it has been definitely reported from northern and southern India, Ceylon, Farther India and Java. *Apis nigrocincta*; *A. socialis*, Latr.; *A. delesserti* Guer.; *A. perrottetii* Guér. and *A. peronii* Latr. are probably only varieties of *A. indica*.

(3) *Apis florea* Fabr. This, the smallest bee of India, is found generally in southern India and Ceylon, and there are indications, that it is common to other portions of the East Indies. *Apis lobata* described by F. Smith in his first catalogue, is dropped from the second edition.

(4) *Apis dorsata* Fabr.
=*nigripennis* Latr.
=*bicolor* Klug.
=*testacea*.

It is somewhat questionable whether the names here given as synonymous are such, or names of true varieties of *dorsata*. *A. dorsata*, known as the Giant East Indian Bee, is found in British India, Ceylon, Farther India and the Dutch East Indies.

(5) *Apis zonata* Guérin. Found in the Philippine Islands and Celebes. Mr. F. Smith enumerated this as worthy of specific rank, when he revised his catalogue in 1876. He referred to its greater size and difference in form of the metatarsus compared with that of *A. dorsata*. But Gerstaecker asserted in 1865 that this difference in structure of the metatarsus does not exist—is "purely imaginary".

Mr. Frank Benton, to whom I am under obligations for valuable information on this subject, has kindly prepared for me the following table as indicating his own ideas of the grouping of the species of Apis, and the known varieties of these.

The Species of Apis with their Varieties.

Apis mellifica* *Linn.*

Race.—Common Brown, Black, or German.—Hab.: Central, northern and northwestern Europe; introduced into N. and S. America, Australia, New Zealand and Pacific Islands.
    Sub-var.—Heath.—Hab.: Heath districts of North Germany.
    Sub-var.—Brabant or Small Holland.—Hab.: Brabant (Holland and Belgium).
Race.—Carniolan.—Hab.: Carniola, Carinthia (Aus.). A distinct var.
    Sub-var.—Hungarian.—Hab.: Northwestern Hungary.
Race.—Dalmatian.—Hab.: Dalmatia (Austria).
Race.—Herzegovinian.—Hab.: Herzegovina (Austria).
Race.—Cecropian, Attic or Hymettus.—Hab.: Greece and the adjacent islands.
Var.—*ligustica* Spin., Ligurian or Italian.—Hab.: Italy and adjacent islands, S. Switzerland, and S. Tyrol; introduced into other parts of Europe, N. and S. America, Australia and New Zealand.
Var.—†*rufescens*—Hab.:—Tasmania (acc'd to M. Girard).
Var.—†*nigritarum* St. Farg.—Hab.: Congo (Africa).
Var.—†**adansoni* Latr.—Hab.: Senegal (Africa).
Var.—*scutellata* St. Farg.—Hab.: South Africa.
Var.—*caffra* St. Farg.—Hab.: South Africa.
Race.—Tunisian.—Hab.: Tunis, Algeria.
    Sub-var.—Minorcan.—Hab.: Balearic Islands (Spain).
Var.—†**unicolor* Latr.—Hab.: Madagascar; intr. into islands of Bourbon and Mauritius.
Race.—Smyrnian.—Hab.: Asia Minor.
Race.—Caucasian.—Hab.: Caucasus.
Race.—Cyprian.—Hab.: Island of Cyprus. A very distinct var.
Race.—Syrian.—Hab.: Syria, northward from Mr. Carmel.
Race.—Palestine.—Hab.: Palestine.
Var.—*fasciata* Latr.—Hab.: Egypt.

Apis sp.

Race.—Hazara.—Hab.: Hazara District, Punjab (India).
Var.—**sinensis*.—Chinese bee.—Hab.: China.
    =*cerana* Fabr.
Race.—Bushar.—Hab.: Bushar District, Punjab (India).
Race.—Japanese
    1. "Grayish yellow bee." } Hab.: Prov. Sinano.
    2. "Bee with yellow spots." } Hab.: Prov. Sinano.
    3. "Small brown bee."—Hab.: Hikigoie (Satsuma)
Race.—Boohtan.—Hab.: Boohtan (India).
    It is very probable that further investigation of this group will bring four of its varieties under *A. mellifica*, and the last one under *A. indica*.

Apis

**indica* Fabr., Small East Indian bee.—Hab.: British and Dutch East Indies.
    =*socialis* Latr.—Hab.: Bengal.
    =*delesserti* Guér.—Hab.: Pondicherry.
    =*perrottetii* Guér.—Hab.: India.
    =*peronii* Lat..—Hab.; India.
Var. (?)—**nigrocincta*.—Hab.: "Celebes, Borneo, etc." (acc'd to F. Smith.

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*Regarded by Frederick Smith as good species.

†Not positively known that they will interbreed with *Apis mellifica*. All others named under *A. mellifica* will do so.

Apis
*_florea_ Fabr.—Hab.: India, Ceylon, Borneo.
=_lobata_ Smith.—Hab.: India.

Apis
*_dorsata_ Fabr.—Hab.: British India, Ceylon, Farther India, Dutch East Indies.
=_bicolor_ Klug.
Var.—_nigripennis_ Latr.—Hab.: Bengal.
Var.—_testacea_ Smith.—Hab.: Timor.

Apis
*_zonata_ Guér.—Hab.: Philippine Islands, Celebes.
This may prove but a variety of _A. dorsata_.

NOTE 3.—Polliniferous Organs in Bees.

The modification of structure and hairy vestiture (see Fig. 2) to facilitate the collection and transportation of pollen is, perhaps, exhibited in its most perfect development in the Hive Bee. That these peculiarities have been evolved from those possessed by less specialized species of social bees, represented by existing Meliponae and Bombi, and still more remotely from those of solitary bees, will not be questioned by those who study the steps in the process as exemplified in modern species.

The pollen of flowers is variously collected by different bees, and different parts of the body are specially developed for this purpose. But in the Hive Bee the specialized polliniferous apparatus is limited to the posterior legs, and in these to the tibia and the basal joint of the tarsus, so that the development of these parts only need be traced.

In the case of the tibia the first thing to be noted is the entire absence of the tibial spurs, which are present in all Hymenoptera except the genus Apis, and its near allies Melipona and Trigona. The tibia and first tarsal joint are greatly broadened and more or less concave exteriorly, and the latter is extraordinarily enlarged, so that it is nearly equal in size to the tibia. The outer surface of this modified tarsal joint is not remarkable and has no specific function, but the inner surface is divided into transverse rows of stiff spines or combs, reddish in color, the rows slightly overlapping and elevated at a slight angle from the surface of the joint. The function of this series of combs is to collect the pollen grains which become entanled in the feathery hairs of the thorax of the insect, and an examination will almost invariably discover more or less of the grains of pollen in these combs. During the collecting of honey and pollen, the bee is constantly passing the face of this tarsal joint over its abdomen, removing the pollen grains from time to time, and emptying the load of pollen into the pollen-basket proper or corbiculum, on the outer face of the tibia. This, as noted, is concave, with a smooth, almost hairless exterior surface, provided at the sides with several rows of long curved hairs, which arch over either side, forming a veritable basket in which the pollen may be securely packed. As soon as the collecting combs of the tarsus are filled, the bee draws them across the strong, curved hairs of the corbicula, the right tarsus emptying into the left corbiculum and *vice versa*, until both are filled. These baskets or masses of pollen are emptied by means of the single strong tibial spine on each of the middle pair of legs, the spine being thrust beneath the load of pollen and used as a pry to loosen and remove it.

A very remarkable peculiarity of the posterior legs, but having no connection with the polliniferous apparatus, is seen at the union of tibia and first tarsal joint. These are articulated at the extreme anterior angles in such a manner that the broadened apex of one and the base of the other, work together as a sort of nippers or pincers. The tibia is armed on the inner margin with a strong, uniform row of short spines extending two-thirds of the way across. This apparatus is employed by the bees in removing the wax scales from the abdomen.

Examination of these parts in other species of Apis fails to indicate any particular modification or deviation in structure from *mellifica*. In *Apis indica* no differences whatever can be discovered; in *A. dorsata* the leg is somewhat more hairy and a few hairs occur on the outer surface of the tibia. In *A. florea* the smallest species known, the spines on the apex of the tibia are somewhat shorter and stouter and the hairs forming the corbiculum are somewhat less regular in length and arrangement.

This statement of the structure of these parts in the species of Apis will enable us to compare intelligently the similar parts in those genera most nearly allied to them, tracing the variation through these to the more widely divergent forms. The genera Melipona and Trigona include bees which are closest to Apis in general structure and habits, and agree also in the absence of the tibial spines of the posterior legs. We find, as might be inferred, a very close correspondence in the polliniferous apparatus, which, in all essential details, is practically the same as in Apis. The pollen-collecting combs on the inner surface of the first tarsal joint are absent, or rather their place is supplied by a uniform clothing of short stiff spines which are not arranged transversely in rows, as in Apis, but serve the same purpose. This joint also differs in shape from that in Apis, by being suddenly narrowed or excavated toward the base so that the nippers noted in the former genus for the removal of the wax are practically wanting, although the row of stiff spines at the apex of the tibia is still present, but somewhat reduced. A very peculiar tuft of strong, curved spines occurs, in the two genera mentioned, at the anterior outer angle of the tibia. This has no counterpart in any other bees and its function is problematical.

In the case of Bombus, the lowest of the social bees, there is at once a greater divergence from Apis and at the same time a resemblence to it in certain features of the hind legs and polliniferous apparatus. The tibial spines are very strongly and prominently developed, allying this genus to the solitary bees and other Hymenoptera, but the general structure of the tibia and first tarsal joint is practically identical with that of Apis, and the tarsal joint in this particular does not present the divergence which was noted in the case of the genera Melipona and Trigona, but has the broadly truncated basal margin forming the lower blade of the nippers, even more strongly developed than in Apis. The pollen-collecting spines on the inner face of the tarsal joint are uniformly distributed over the surface, practically as in the two genera last mentioned (Melipona and Trigona). The bordering hairs of the corbiculum are somewhat stronger and more abundant, but in all essential details the structure is identical with the same in Apis.

The solitary bees of the genus Anthophora, which is somewhat nearer Apis than any other, present distinct traces of the specialized polliniferous apparatus of this last. The enlargement of the tibia and of the first tarsal joint is quite marked, and the corbiculum is imperfectly indicated by the longer growth of hairs on the edge of the tibia, the face of the latter being also covered with shorter hairs. The brush or pollen comb on the inner surface of the tarsal joint is practically the same as in Bombus. The small row of spines at the apex of the tibia are entirely wanting, and the nippers at the junction of the tibia and metatarsus are not particularly noticeable; in fact this structure is not seen in any except the social bees which alone produce and use wax in their economy. The genus Melissodes presents a distinctly wider divergence from Apis, in that the hairy vestiture on the outer surface of the tibia and metatarsus is equally long and dense over the entire surface, showing little if any approach to the corbiculum, which, as we have seen in Anthophora, begins with the shortening of the hairs on the outer face of the tibia. In other particulars the bees of this genus are similar to Anthophora, and in both genera the pollen collected is carried interspersed among the hairs of the tibia and tarsus, being doubtless emptied or combed into them from the brush of the inner surface of the first tarsal joint, and probably removed again by the same brush in storing it in their larval cells.

Going still lower in the scale of bees, we find in Perdita a yet wider divergence from Apis in the absence of any particular dilation of the tibia and metatarsus, the posterior legs being similar to the anterior members, simple in structure, and armed with long, scattered, feathered hairs, which are generally distributed over all their surface and which entangle more or less of the pollen grains. The brush of the inner surface of the metatarsus is still present, and in fact occurs in all Apidæ and Andrenidæ. The genus Nomada is still less specialized, in that the legs are simple, not dilated and also practically hairless; or rather the hairs are short and simple and have no pollen-collecting capacity. In this genus the brush of the metatarsus can hardly have any other use than to keep the body of the insect clean, as these bees are pseudo-parasitic or inquilinous and do not collect or store pollen. It is a mere modification of the normal or original structure and doubtless a degeneration due to the semi-parasitic habit.

From the above review of the modification of the posterior legs as polliniferous organs in various genera of the family Apidæ, it will be seen that there are first developed on the leg, hairs which are feathery and which will entangle the grains of pollen. The next step in the development is an increase in the abundance of this hairy vestiture, and a further advance occurs in the widening of the tibia and first tarsal joint, to give a greater surface for the pollen-collecting, plumose hairs. This reaches its maxium in the genus Melissodes in which the external hairs of both the tibia and the metatarsus are very long and dense and the feathering very decided. The next step toward the condition found in Apis is exhibited in Anthophora, and consists in the partial disappearance and shortening of the hairs on the outer face of the tibia and metatarsus, by which means an imperfect corbiculum is formed, foreshadowing the more complex structure of the social bees, in which it becomes quite well developed in Bombus and perfectly so in Trigona, Melipona, and Apis. In Anthophora a further modification is noted in that the hairs of the legs are practically simple and unfeathered as in the higher social bees.

In the other family of bees, the Andrenidæ, we have a similar condition of things, the variation in the pollen-collecting character of the posterior legs ranging from Agapostemon to Prosopis, and showing the same gradations noted in the Apidæ from Melissodes to Nomada.

The reader interested in studying how the mouth-parts and the legs have been modified in the bees by their honey and pollen gathering habits, cannot do better than consult Hermann Müllers' works* on the subject. There is almost an unbroken chain of these characters, from the highly developed bees to such as are hardly distinguishable from the fossorial wasps.

NOTE 4.—Wax-producing organs.

In all the wax-producing bees the specialized discs (see Fig. 3) on which the wax is deposited when secreted by the true glands beneath, occur on the basal half of the second to the fifth ventral segments of the abdomen, the overlapping half of each segment covering and protecting the disc of the succeeding segment. With the Hive Bee these discs are compound and two in number on each segment. They are broad, ovate, pale yellow in color, smooth, delicate and transparent, and are surrounded by a narrow thickening of the chitine of the sclerite and separated by an unmodified medio-ventral septum. This specialized structure occurs only in the workers. The queen, however, has a sub-obsolete, undivided area on the same five abdominal segments, and which in structure bears a striking resemblance to the similar area in the workers of the lower forms of social bees. The wax discs of Melipona and Trigona are practically identical, and are narrow, extending entirely across the base of the segment, not being broken, as in Apis, with a dividing septum, and also extending laterally nearly to the apex of the sclerite as in the case of the fertile female in Apis. In Bombus the structure is almost identically the same as in Melipona.

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*The Fertilisation of Flowers, by Prof. Hermann Müller. Translated and edited by D'Arcy W. Thompson, B. A., London, 1883.

NOTE 5.—Ant Economy.

Considering the large number of species of ants, a book would be required to treat of them in detail, and volumes have been written. In this note I shall only treat of a few of the better known, to supplement the mere summary in the body of the address. The most interesting of our North American species which I have had an opportunity of studying are the mound-building species of the East, the leaf-cutting species of Florida and Texas, and the honey ants of Colorado. With the aid of Mr. Th. Pergande, who has been assiduous in his studies of the family, and is perhaps our best-informed myrmecologist, I have brought together a number of notes on the habits of our North American species of Carpenter Ants and others; but they are excluded as the least important in connection with the text, and with a view of duly limiting the pages.

MOUND-BUILDING ANTS.—In this category may be classed by far the larger number of our better-known ants. The term is, however, particularly applicable to the species of the genus Formica. These ants are very much more active and industrious and typical of the family, than are the carpenter ants. Our own species inhabit, by preference, pine woods. They are pugnacious and valiant, and whenever their mound is disturbed, however slightly, will speedily cover the whole surface in one surging mass, spreading over the mound and attacking in their fury any living creature within reach. They are in fact so fierce and fearless that even man does well to avoid their mounds; for the bite is quite severe, and when multiplied indefinitely is unbearable.

The Fallow ant (*Formica exsectoides* Forel), one of our best known species and a close ally of *F. exsecta* of Europe, builds large mounds of earth, more or less mixed with other materials, especially small sticks and dried leaves of pine. These will measure all the way from two to eight feet in diameter at the base, and may be from one to three feet high. They are more or less regular and conical, full of galleries, with larger or smaller chambers which communicate with a general system of subterranean cells or cavities, which are used as store-rooms, nurseries for the young, parlors for the queens, and other purposes. The purpose of the superstructure in most mound-building ants appears to be for aëration, for the more rapid development of the larvæ, and, apparantly, to facilitate social intercouse between the individuals when not engaged in actual work. Except for the extraneous matter which gives it firmness, all the material of the mound is brought up from beneath the surface, and the inhabitants are incessantly at work, night and day, in constructing, altering and repairing. Very large colonies are often connected by secondary hills. I once had a good opportunity of studying these mounds around Ithaca, N. Y., and Dr. H. C. McCook has published a most interesting and detailed account of his observations upon this ant in the Trans. American Entomological Society for 1877, Vol. VI, page 253, and also in *The American Naturalist* for July, 1878, Vol. XII, pp. 431–445. It is particularly common in the Alleganies. There are three forms of workers, viz, major, minor and dwarf. His interesting observations will well repay reading.

It is in these mound-building ants that we find the true economy of the division of labor. While large numbers are ceaselessly building and mining, so as to keep the formicary in good condition, repairing or increasing its size, so as to accommodate the growing numbers, others are busily engaged in scouring the surrounding country for food, both for themselves, for the multitude of those who stay at home, and for the young. In these expeditions they never hesitate to attack any other insect that may be in their way, no matter how much larger than themselves, and what they lack in power individually they make up in numbers. Still others again are running over the trees and shrubs and other plants, searching for plant-lice, from which they gather the sweet rejectamenta, gorging themselves frequently to such an extent that they return home with difficulty. This honey is used chiefly for feeding the larvæ.

Honey Ants.—There is really but one Honey Ant, strictly speaking, viz, *Myrmecocystus melliger* Llave (*M. mexicanus* Westm.), in North America, and this ranges from Mexico to Colorado. Other species occur in other parts of the world, with somewhat similar habits, and one is especially mentioned by Lubbock from Australia (*Camponotus inflatus* Lubb.) which has undergone precisely the same modifications, though belonging to a distinct genus, a most interesting fact, since it shows that the modification has arisen independently. The honey collected and stored by these ants has little value commercially, first, because of its rather poor quality; secondly, because of its small quantity—barely more than half a pint to each colony—obtainable; and, thirdly, because of the difficulty of colonizing or in any way commercially manipulating the ants. The insect must be crushed to obtain the honey. Yet it is sought for by the Mexican Indians, and used to a considerable extent. The formicaries are little truncated cones from two to three inches high, and usually less than a foot in diameter. They have a tubular channel, a few inches in diameter, leading from the central opening to the interior, to a depth of six inches or more below the general surface. Here are often found one or more dome-like vaults or honey-chambers, about an inch deep by about three inches in width. Hanging from the roughened roof of these chambers may, at any time, be found numbers of the honey-bearers, with immensely swollen abdomens and looking, when congregated, like a series of small grapes or large currants, with the same translucency which these possess. These individuals have little capacity for movement, and indeed move but little. They are but living receptacles of the sweets which are gathered by the real workers, and the food-supply of the rest of the colony is only drawn from these stationary honey reserves, or animated honey pots, as Lubbock calls them, when necessity requires. The modifications are confined to the abdominal portion of the digestive organs. The honey is gathered from a little Cynipid oak-gall which I have described as *Cynips quercus-mellaria* and which abounds on a small scrubby oak (*Quercus undulata*) frequent in those regions. The ants always work at night, making their way in long strings to the nearest gall-bearing tree, the branches of which they carefully search for the young and succulent galls which secrete a small globule of a clear saccharine liquid. The gathered liquid is then, upon the return to the formicary, emptied into the mouths of those individuals which serve as honey stores.

Leaf-cutting Ants.—These are represented almost solely by the genus Atta, which abounds in tropical and sub-tropical countries, where the species are dreaded by planters because of their great destructiveness to cultivated plants and trees. These ants have been denominated agricultural ants, and recent observations have confirmed the explanation originally urged by Belt, that the leaves are cut into pieces and gathered into small heaps, as a nidus for the cultivation of a fungus (Rozites) the mycelium form of some mushroom, so that they may be said to have anticipated man in this kind of culture. The only two species belonging to the genus so far observed in this country, are *Atta fervens* Say, and *Atta tardigrada* Buckley. The former is our commonest species, occurring in Texas. Its formicaries are often twenty feet in diameter and several feet high, with numerous smaller moundlets scattered over the surface. They have a crater-like depression in the top, with a central opening running down into the formicary, sometimes to a very great depth. Each formicary contains immense numbers of individuals, and during the day appears to be empty and deserted. After dark, however, the entrances are opened, first by smaller workers who remove the particles of sand and earth, then by individuals of larger form who aid in removing the refuse. When the way has been sufficiently cleared, the inmates pour forth, both workers and soldiers, and march to some plant or other near by. They are generally seen in double column, one column ascending the plant and cutting off the leaves, and the other returning loaded to the nest. Great intelligence is shown by this ant in its foraging expeditions. The cut leaves, either whole or in circular pieces, are usually thrown on the ground by those who ascend the tree, while others below receive and bear the fodder home. Each piece of leaf is grasped by the jaws, and, with a quick motion of the head, thrown back over the head and thorax in such manner that it lodges edgewise in a deep furrow and between two spines which characterize the head, so as to cover the insect more or less and offer little or no obstacle to its progress. Very long underground tunnels are sometimes excavated from the main formicary to some shrub or tree so as to facilitate access thereto. The stories told by southern planters of the ravages of this insect seem almost incredible, but I have myself witnessed the utter denudation of a large tree in a single night, in which case all the forces of the formicary seemed to be concentrated on a single object.

Atta tardigrada is found east of the Mississippi River, occurring throughout the gulf States from Florida to Texas. In Florida what is evidently this species builds rather large cells from two to four inches in diameter in fine white sand, the walls very firm and smooth. In some instances the walls are said to be lined with a kind of curtain composed of particles of different colored sands brought up from a lower stratum and interwoven with fine white threads, by which is doubtless meant shreds of the refuse vegetation collected—a kind of spongy mass, manufactured from the vegetation and somewhat resembling the comb made by certain bees. This spongy mass contains small irregular pockets, apparently designed for the reception of the young, and in this we have the nearest tendency in ants to the building of cells which is so common in some of the other social Hymenoptera. This species prefers the fine needle-like leaves of tender pine seedlings, and a row, marching in single file, each carrying a piece of one of these needles, suggests a file of soldiers armed with rifles.

Atta mexicana Sm. abounds in the temperate regions of Mexico, its formicaries being twenty or more feet in diameter, and a funnel is said to extend through its center to facilitate drainage, which would seem to be necessary in a country subject to very heavy rains. The damage done by this species, especially to coffee plantations, is said to be very great.

Atta cephalotes L. is dreaded in Brazil because of its destructiveness to vegetation and of its tendency to enter houses and carry off the mandioca meal. Its formicaries often reach a diameter of more than 100 feet.

NEST-BUILDING ANTS.—Though we have in the United States no species which constructs nests similar to those of wasps, yet such are known to occur in other parts of the world, especially in tropical and sub-tropical countries. The genera Polyrhacis, Dolichoderus and Cremastogaster imitate wasps in the construction of their nests.

Some of the Brazilian species of Cremastogaster construct more or less globular, black nests, about the size of a human head, fastened between the branches of trees, large numbers of which may often be noticed among the mangrove bushes bordering the shores of the ocean, and frequently so low down as to be but a few inches above high tide. Similar nests are common in the West Indies, and look very much like young nests of Eutermes.

The nest of *Cremastogaster arboreus* Sm., found at Port Natal, Africa, is very large, measuring about fifteen inches in length, by nine inches in diameter. It is always built around a branch, resembles in texture and appearance the nest of our common paper wasp, *Vespa maculata*, and contains thousands of the insects. (See Smith, Cat., Hym. Ins. Brit. Mus. Pt. VI, pl. XIV.

We see the beginnings of the nest-building habit in some of our North American species, especially in *Cremastogaster lineolata* Say, which builds coverings over colonies of Aphides, the coverings composed of minute particles of vegetable and earthy matter firmly glued together ; or else makes a more or less conspicuous loose nest by massing together the exuviæ of the Aphides and portions of dead leaves, generally around some twig or branch. (See *Practical Entomologist*, Vol. II, No. 3, Dec. 1866, p. 41.) In this case the object is doubtless to prevent the robbing of the coveted sweets by other nectar loving species; while the more elaborate nests of the tropics are for self protection and social economy, the nearest approach to these in N. A. being made by a Florida ant (*Cremastogaster læviuscula* Mayr) which makes large brown chambered nests in long grass, recalling somewhat in color and character those of Entermes.

Note 6.—Termite Economy.

True royal Pairs.—There are many recondite phenomena connected with the life-history of the Termites that yet remain unexplained. But all the species annually produce large numbers of male and female adults, i. e., winged individuals which are capable, normally, of reproducing. These are recognizable after the first moult by the larger thoracic segments, which bear the first indication of wing-pads. During flight or swarming, and the subsequent walks on the ground, no real union of the sexes has so far been observed. In fact the reproductive organs are at this period not fully developed, and it is not until a pair have succeeded in establishing themselves amid a certain number of workers that the sexual organs become functional. The wings are thrown off and at this stage these individuals are known as true royal pairs, the wing stumps showing in contradistinction to the wing-pads of the larva and pupa, while their darker color otherwise distinguishes them. They are long-lived, coition taking place repeatedly. The male increases but little in size, but the abdomen of the female increases enormously with increasing fecundity.

Supplementary Kings and Queens.—The absence of a true royal pair by no means impairs the vitality and prosperity of a Termite colony; for a certain number of individuals are met with which, in the absence of the true queen may become sexually mature. the female laying fertile eggs, from which, in due course of time, all the forms composing the colony are developed. The true nature of these secondary or supplemantary males and females was first fully recognized by Fritz Müller, and their development is explained as follows:

At first indistinguishable from the larvæ of individuals which produce winged specimens, they are, in the nymph or pupa state, thicker and clumsier. The internal sexual organs are more strongly developed, and they have short wing-pads placed sideways instead of long and broad wing-pads as in the nymphs which produce the true kings and queens. In short, they undergo one moult less, and, as a consequence, do not acquire wings or swarm. They acquire sexual maturity later in the season than the winged individuals, from which they are always distinguished in maturity by the possession of wing-pads instead of the wing stumps. They are also lighter in color, the males having smaller eyes, and the females a broader thorax, whereas in the true royal individuals there is no difference in this respect. They are not as long-lived, either, as the royal pair, the males dying within a few months and the females probably not surviving more than a year.

It will be seen from the above stated facts that if through the death of a queen, or in the absence of a queen, a colony has not been able to secure another royal pair from the swarming individuals "nymph-like males and females, safely kept in the nest" step in as substitutes and save the colony from becoming extinct. Furthermore it has been observed that if, in very small and fragmentary colonies, the supplementary males and females should be absent, the colony may yet be perpetuated by the substitution of larva-like males and females, which have been called complementary kings and queens.

A remarkable observation made by Fritz Müller deserves mention here. He found in a Eutermes colony, in the passages of what appeared at first to be a true royal cell, not less than 31 supplementary females and among them a single true king. i. e., with distinct wing-stumps. "Instead of a royal palace" he says, "in which the king lived in chaste matrimony with his equal consort, I had a harem before my eyes in which a sultan satisfied himself with numerous coquettes." This observation would seem to indicate that, in the economy of the Termite colony, a true king and queen may not only be replaced by supplementary kings and queens, but that this substitution may take place for both sexes at the same time, or for each sex separately.

I would observe, in this connection, that during the swarming season many species of true ants forcibly detain some of the winged males and females and prevent their leaving the formicary by biting off their wings, and that the pairs thus forcibly detained supply the colony with eggs. A similar condition may prevail among the Termites, and if so, would throw light on some of the facts which have been observed.

INFLUENCE OF FOOD AND TREATMENT.—The effect of food and treatment has less, perhaps, to do with the differentiation of individuals among termites than among the bees, wasps or ants.

All Termite larvæ are supposed to partake of the same kind of food, as to the nature of which there is conflict of opinion, due doubtless to the varying habits in the different species. From my own observations on Termes and Eutermes, I am inclined to believe that, as in the Social Hymenoptera, the food and treatment of the young larva, during the first stage more particularly, have much to do in determining the development or suppression of the sexual organs, and, as a consequence, in determining the character of the full grown individual. The eggs are, first of all, brought together in special parts of the termitary, and it is quite probable that the workers exercise some judgment and discrimination in the grouping, as has been proved to be the case with Hymenoptera, with a view to future larval treatment. Judging from the delicacy of their mouth-parts and of the general integument, the young are at first more or less dependent upon either the forethought or the direct action of the adults, and I cannot resist the conclusion that the infancy of the termites is dependent, as it is in the Social Hymenoptera, if not to the same extent; for they have soon perished where I have hatched them away from adults, and have developed where the adults had access to them. But further exact observations, which, in the nature of the case, it is difficult to make, are needed before definite conclusions can be drawn. Fritz Müller believes that the young feed on a fungus which develops on the walls of the cells, a peculiar white fungus being not uncommon in such situations, though I have more often found nothing of the sort where the young were abundant.

Mr. Hubbard found many small hard bodies among the eggs of *Eutermes rippertii* which were recognized as the sclerotium of a fungus by Prof. F. G. Farlow, and other observers have referred to the presence of fungi in Termite nests. Mr. Hubbard also records the feeding of the young upon hard and tough rounded masses found in the nests of the above-named species. They could not do so, however, without the assistance of the nasuti or workers to soften these nodules, for their mouthparts are too feeble, while the nodules are of very irregular occurrence and in some nests not present at all. Where the young are crowding, the material of the nest is moister than elsewhere and their chief food must be a liquid regurgitated from the mouth, by the workers or by the partly developed sexed individuals, just as in the social Hymenoptera, and either taken directly or from the moistened substance of the cavities. Indeed, though Mr. P. H. Dudley in some interesting observations on Eutermes on the Isthmus of Panama (Journal N. Y. Micros. Soc. V. p. 62, April, 1889) describes the nasuti as being able to fire an "offensive glutinous shot, which puts an antagonist twice his size *hors de combat*," I have never been able to confirm this statement. The nasuti have seemed to me defenseless and I suspect that the liquid so readily secreted from the tip of the nose is chiefly designed for nourishment. That comminuted, decayed wood, as well as the faeces are also used for food has been shown by Grassi and others, while the tendency to feed freely upon one another is matter of common record, and indeed all the dead and dying are devoured.*

In Calotermes the excrement consists of dry and hard sub-ovoid particles which accumulate in the burrows, so that the faeces are not used here whether as food or to line the burrows. Consequently the young must depend entirely on liquid from the mouths of the females. The food is, however, from what has gone before, sufficiently varied in those species which exhibit the greatest number of colony forms, to justify the belief, here set forth, that it has much to do in the development of those forms.

It is, however, definitely known that differentiation of the sexes takes place at an early period, and can be recognized by anatomical and external characters in the larva, immediately after the first moult. Freshly hatched larvæ appear to be sexually undifferentiated, although it is probable, as suggested by Newman in 1853 and Hagen in 1855, that this is simply because the differences are too minute to be observed. Sex is doubtless determined in the egg, but the different forms of either sex are, in all probability, due to food and treatment in the first larval stage, and to an innate tendency confirmed by heredity. The mode of treatment of the mother, in insects generally, may influence the sex of the offspring; but there is no evidence to show that the sex can be altered when the egg has once passed. Fecundity varies in individuals of any community, and a certain number are always sterile. In the social insects this condition is simply controlled to the advantage of the species, and the tendency, associated with various other modifications, has been emphasized by heredity. Prof. B. Grassi (Bull. Mensuel Acad. Gioenia, 1889; Entom. Nachrichten, 1889) has offered a rather curious explanation of the origin of the sex in Termites. He finds in the cœcum of the young larvæ, as well as in the fully developed workers and soldiers, an abundance of protozoon parasites. With each moult these parasites disappear, but immediately commence to reappear, and the cœcum is inflated in a sac which presses on the sexual organs so that the development of the latter is prevented, the protozoons not appearing, after the first moult, in those individuals which are to become truly sexual, or at least in only the smallest quantities. He bases this view upon the examination of many hundreds of individuals, but the probabilities are that the presence of the protozoons has no essential part in the result, as he offers no explanation as to why they are absent or less numerous in the one case than in the other.

Composition of the Termes Colony.—Remembering that in Termes the adolescent stages actively participate in the work and composition of the colony, and accepting the nomenclature most recently used by the latest and best observers, the forms already indicated in the diagram on p. 33 may be enumerated as occurring in the species of the genus Termes, as exemplified by the commoner European and American species:

Prof. Grassi has enumerated some three additional forms, but this confusing complexity of forms really occurs only among those which are reproductive and they never all occur at one and the same time, while some of them only occur under certain peculiar conditions.

The youngest larvæ, i. e., the indistinguishable freshly hatched larvæ of all forms (No. 1) are very small, in no species attaining 2 mm. in length. They are delicate, feebly chitinized creatures, blind, the thoracic segments not specialized, and with short 9-to 10-jointed antennæ. After the first moult the differentiation into neuters and sexed individuals becomes appreciable, not only in the beginnings of the development of the sexual organs, but in the increase in the number of antennal joints. The larvæ and sub-

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*By placing a small quantity of arsenic or calomel mixed with sugar in their burrows or nests, the termites will greedily devour the mixture, and by means of the poisoned individuals being fed on as fast as they perish, the whole colony will in time be destroyed.

sequent stages of the neuters remain eyeless and the thoracic segments are very little altered, since they develop no wings. But after the second moult a further differentiation takes place between the larvæ of the ordinary workers and soldiers, those of the former being recognized by the small head, smaller mandibles, large maxillæ and labium, while those of the latter have a much larger head, very prominent mandibles, variously modified according to species, and much smaller maxillæ and labial parts. In the perfect workers and soldiers these differences are still more strongly marked, and both forms may at once be distinguished from other larvæ by the darker color and the shining and harder integuments.

A peculiar form of neuter, occurring in Eutermes, the so-called nasuti, remained a puzzle for a long time. In this form the head is pear-shaped and prolonged anteriorly into a tube or nose which possesses a channel leading backward into the head. The nasuti have the power of secreting a viscid liquid from the tip of this nose. The mandibles are not prolonged and are unfitted for biting, while the lower mouth-parts are but little better developed than in the common soldiers. Dr. Hagen in the Appendix to his famous monograph of the Termes, recognized this form as a soldier form, characteristic of the genus Eutermes, which replaces the large-headed and mandibulate soldiers of the other genera. Mr. Hubbard, however, records having found in one colony of *Eutermes rippertii* in Jamaica a few of these nasuti among the soldiers (Boston Soc. Nat. Hist., 1877, pp. 270–2). It is believed, and I think justly, by Fritz Müller that when found in colonies of other Termites having mandibulate soldiers, these nasuti are mere inquilines or intruders, and the opposite view is justifiable, that when the mandibulate soldier is found among the nasuti, it also is an intruder.*

Acknowledgment.

Figures 1, 2, 3, 8, 9, 10 and 11, are made from illustrations belonging to the Department of Agriculture, and are used by the kind permission of Chas. R. Dabney, Jr., Assistant Secretary of Agriculture.

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*Since this address was written, I have had an opportunity of studying Eutermes in the West Indies, *E. morio*, at St. Thomas, St. Kitts, Monserrat, Dominica, Martinique, St. Lucia and Barbados, and both it and *E. rippertii* in Jamaica. The nasuti are here the smallest individuals in the colony and also somewhat the darkest. They have no power of biting, and no organ of offense, as the liquid exuded from the tip of the nose has no pungent property. They may, therefore, be handled with perfect impunity Of some forty nests examined none have furnished a mandibulate soldier. The nasuti, though having no weapon of offense (so far at least as man is concerned) are nevertheless active guards, and undoubtedly take the place of the soldiers in Termes proper. They crowd around the queen, when the colony is disturbed, and rush to the outside and about the borders of any breakage or hole made in the nest or the tunnels thereto. They throw up the head and play the antennæ and palpi in a comically threatening way, considering their inoffensiveness, and they watch around the borders on the inside of such breakage while the workers run up rapidly now and again to deposit the soft excrement which is to mend the gap, and of which the tunnels and nests are for the most part formed. Eggs and young larvæ are frequently borne on the nose and on the feelers of these nasuti; but I have not yet satisfied myself that they are thus purposely carried, and are not accidentally stuck by the exuding liquid, the latter view comporting best with most of the cases. But that these nasuti perform some function in the economy of the colony other than that of soldiery defence, is rendered almost certain by their relatively large numbers compared with the real soldiers in Termes, for they are generally as numerous as the mandibulate workers and sometimes as numerous as all the other individuals together. While the liquid from the nose may be used in cementing the walls of the tunnels, I am inclined to believe that it is of more importance in furnishing the first pabulum of the young.

Eutermes rippertii differs little from *E. morio* in habit except that the hard, paler nodules generally found in its older nests do not occur in those of the latter. But the most interesting experience, which is born out by the observations of Mr Dudley on the species in Panama, is that I have found as many as nine queens in one nest and often three or four. In fact there is every variation, even in independent nests which apparently have no accessory mother-nest, from those without queen to those with one up to nine (or more according to Dudley), while in one nest I found scores of true royal pairs in which the queens had undergone no material enlargement. I have also found either no male or sometimes two and once three males associated with a single queen. Ordinarily, however, there is but a pair, i. e., one queen and her escort.

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PROCEEDINGS

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FOSSIL CYCADEAN TRUNKS OF NORTH AMERICA, WITH A REVISION OF THE GENUS CYCADEOIDEA BUCKLAND.

BY LESTER F. WARD.

The recent discovery of a large number of fossil cycadean trunks in the Cretaceous rim of the Black Hills, has furnished a new stimulus to the study of these forms in America. Such objects have been found at no less than six distinct North American localities. The oldest and best known forms are those first mentioned by Tyson from the Lower Cretaceous of Maryland. Dr. Emmons found one such in the Trias of North Carolina, and Sir Wm. Dawson another in the Trias of Prince Edward Island. All the rest, with one exception, are from Cretaceous strata, the age probably not widely differing from that of the Maryland specimens. These are from the Trinity division of the Comanche group in Southern Kansas, and from two localities among the foot-hills outside of the Red Beds of the Black Hills region in South Dakota. The exception to this is the *Cycadeoidea mirabilis* (Lx.) Solms (*Zamiostrobus mirabilis* Lx.), found on the surface of the ground by Dr. F. V. Hayden, near Golden, Colorado, within the Laramie, or Post-Laramie terrane. This locality is at the foot of the Front Range, and it would have been very easy for an erratic block to be borne down the mountain side and lodged in the valley where this was found. As is well known, older formations are encountered on ascending the eastern slope of the Rocky Mountains, and Cretaceous and Jurassic strata undoubtedly crop out immediately above this locality.

Early in the spring of 1893, the National Museum obtained possession of a collection of six fine cycadean trunks from parties residing at Hot Springs, South Dakota, who had collected them at that vicinity.* One of these specimens measures thirty-one inches in height and twenty-four in greatest diameter, and weighs nine hundred pounds; the others are comparatively smaller, the smallest of all not exceeding a foot in height. Most of them are considerably flattened, but one or two are nearly circular in cross section. One of them exhibits a number of lateral branches, and in most cases the apex is depressed, forming the "crows nests" so characteristic of the specimens from the Isle of Portland, Dorsetshire, England.

In the Geology of the Black Hills, prepared by Professors Newton and Jenney, from their survey of 1875, and published at Washington in 1880, none of the Cretaceous strata below the Dakota group of Meek and Hayden, are recognized; and while I presumed from the general history of this class of vegetation that these remains came out of the Triassic Red Beds, or the overlying Jurassic, I was still so greatly interested to ascertain their true source that early in September last I made an expedition to the region, and in coöperation with Professor Jenney discovered the locality and made further collections, including one very much branching and very large trunk and many interesting fragments. All the remains of this class that have been thus far found in the southern part of the Black Hills, occur in the area mapped as Dakota group by Professor Newton, and, although no cycadean vegetation had yet been found amidst the extensive collections from the Dakota group of Kansas, Nebraska, and other more eastern localities, we were at first disposed to accept this as proof of their occurrence at that horizon in this region. But the great improbability of this assumption led us to make a careful examination of the series that had been thus classed by Professor Newton. The result was that we came to the conclusion that the Dakota group of Newton is much more extensive than the No. 1 of Meek and Hayden, and while the upper portion of it certainly belongs to the true Dakota, the lower portion very probably extends to near the base of the Cretaceous. The evidence upon which these conclusions rest will soon be published, and it need only be added that the cycadean trunks belong to this lower portion though not very near the base and may not differ greatly in age from those found in Southern Kansas and Maryland.

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*See Science, Vol. XXI, New York, June 30, 1893, p. 355.

At another part of the Black Hills region, within the foothills on the Eastern side, some six or eight miles north of Rapid City, and between that place and Piedmont, and also probably in the Cretaçeous area, two other specimens have been found and are now at the State School of Mines at Rapid City. The whereabouts of these specimens was not known at the time that I visited that section, but since my return Professor Jenney, appointed at about that time Dean of the Faculty of the State School of Mines, has discovered them there and has furnished me the data for the brief description given below, together with rough drawings, and measurements, From him I learn that in 1877, Mr. J. M. Leedy, then of Rapid City, now residing in Florida, found these specimens at the place stated, that they remained at his ranch for some time, were then placed on exhibition at a fair held at Library Hall, and not being supposed to have any value, were subsequently thrown out into a vacant lot, where they remained until removed to the School of Mines. These forms are much more cylindrical than those found in the southern section, and seem without doubt to constitute a new species. I have therefore named this species *Cycadeoidea Jenneyana*, in commemoration of Professor Jenney's great services to the people of that section as well as to science in general.

I have not seen Professor Cragin's specimens from Southern Kansas, and he unfortunately did not figure them, but he stated in his description that they very closely resemble the Maryland specimens, of which he had obtained a photograph and had learned some particulars as to size. While he thought these two forms were specifically identical, it is probably best to let them remain as distinct species for the present.

All of our American forms appear to belong to the genus Cycadeoidea of Buckland. None of the taller, more slender, palm-like, or branching trunks, belonging to the Old World genera Bucklandia and Cylindropodium, have yet been discovered this side of the Atlantic. The genera Fittonia, Yatesia, and

Platylepis, in which the leaf-bases are persistent, seem also to be absent. I have therefore made a careful revision of the genus Cycadeoidea condensing into it the Bolbopodium and Clathropodium of Saporta, and also referring to it all the species of Bennettites of Carruthers. The greater part of all this had already been done by the recent researches of Count Solms-Laubach, and it only remained to pick up a few of the outlying forms that did not come within the purview of his studies. If his results are accepted at all there is no logical stopping-place short of the embodiment of all these forms under the genus Cycadeoidea. It is of course possible that future exhaustive study, especially from the standpoint of internal structure, may result in the subdivision of this genus into several. But at present the tendency is toward consolidation, and a great uniformity is found in both the external and internal characteristics of the extinct Cycadaceæ.

In a much more extended paper, which is now in preparation, I hope to bring out the special characteristics of our American forms and to compare them with those of the Old World. Sections are now being made of some of the specimens from the Black Hills, and it is proposed to illustrate the internal structure of these specimens as fully as possible. Prof. F. H. Knowlton has consented to superintend the work of section cutting and to prepare the part of this paper relating to internal structure. Thus far we are in possession only of the Black Hills material and the single specimen of *C. mirabilis* described by Lesquereux in his Tertiary Flora. This specimen was loaned several years ago to count Solms who made sections of it and prepared several slides, duplicates of which he sent back with the specimen. I also have a somewhat careful description of what he found, not only in letters received from him, but also in his memoir on the fossil cycads of Italy. Should other material come into our hands it will also be treated from the same standpoint.

I have endeavored in all cases to conform strictly to the law of priority now so rigidly enforced in all departments of natural history. I have been careful to give dates, so that the reasons for the deviations from the more current designations may be clear. If I have made any mistakes in this respect I shall be very thankful to receive corrections before the final paper is completed, this being one of the objects of this preliminary one.

REVISION OF THE GENUS CYCADEOIDEA BUCKLAND.

Genus Cycadeoidea Buckland.

1827. Cycadeoidea Buckland, Proc. Geol. Soc, Lond., Vol. 1, No. 8, pp. 80-81 (Session of June 6, 1827).
1828. Cycadeoidea Buckland, Trans. Geol. Soc. Lond., 2 Ser., Vol. II, pp. 375-401, pl. xlvi–xlix.

This genus seems to be the ultimate destiny of all cycadean trunks of dwarf bulb-like or conical form, deciduous leaf stalks and rhombic leaf scars. Count Solms-Laubach has already referred many of the species of Bennettites and Clathropodium to it, and the Marquis Saporta admits that one species of Bolbopodium belongs to the same genus as *C. pygmæa.* The fact alone that fruit has been found in one species (*C. Gibsoni*) seems insufficient ground for retaining the genus Bennettites. The only other name that has any claim to retention for this group is *Mantellia* of Brongniart, but his publication of it at the same date with Buckland's Cycadeoidea was a *nomen nudum,* and had moreover been used for an animal fossil. It is therefore generally given up. Brongniart himself conceded this, but wrote *Cycadoidea* on grounds of euphony. Even this cannot be allowed by the now more and more strictly enforced rules of nomenclature, and *Cycadeoidea* must stand as originally written by Buckland.

Cycadeoidea megalophylla Buckland.

1827. Cycadeoidea megalophylla Buckland, Proc. Geol. Soc. Lond., Vol. I, No. 8, p. 80.
1828. Trans. Geol. Soc. Lond., 2d Ser., Vol., II, pp. 397–401, pl. xlvii, figs. 1–4; pl. xlviii, figs. 1–3.
1828. Mantellia nidiformis Brongn., Prodrome, pp. 96, 199.
1837. Mantellia megalophylla (Buckl.) Bronn, Lethaea Geognostica, p. 227, pl. xv, fig. 2.
1837. Cycadites megalophyllus Buckland, Geology and Mineralogy, etc., Vol. I, p. 497; Vol. II, p. 98; pl. lx, figs. 1, 2.
1838. Zamites megalophyllus (Buckl.) Presl, in Sternberg's Versuch, etc., Vol. II, Hefte 7 and 8, p. 196.
1842. Encephlartos Bucklandii Miquel, Monogr. Cycad., p. 60.
1849. Echinostipes nidiformis (Brongn.) Pomel, Matériaux, etc., p. 16.
1874. Clathropodium megalophyllum (Buckl.) Saporta, Pl. Jurass., Vol II, p. 285, pl. lxxvi, fig. 1.

Purbeck beds, Isle of Portland, Dorsetshire, England.

Cycadeoidea microphylla Buckland.

1827. Cycadeoidea microphylla Buckland, Proc. Geol. Soc. Lond., Vol. I, p. 81.
1828. Trans. Geol. Soc. Lond., 2d Ser., Vol. II, pp. 398–401, pl. xlix, figs. 1, 2.
1834. Strobilites Bucklandii L. & H., Foss. Fl. Gt. Brit., Vol. II, p. 133, pl. cxxix.
1837. Mantellia microphylla (Buckl.) Bronn, Lethaea Geognostica, p. 227.
1837. Cycadites microphyllus Buckland, Geology and Mineralogy, etc., Vol. I, pp. 497, 498; Vol. II, pp. 98, 99, 100, pl. lxi, figs. 1–3; pl. lxii, figs. 2, 3.
1838. Zamites microphyllus (Buckl.) Presl, in Sternberg's Versuch, etc., Vol. II, Hefte 7 and 8, p. 196.
1849. Echinostipes microphyllus (Buckl.) Pomel, Matériaux, etc., p. 16.
1874. Clathropodium microphyllum (Buckl.) Sap., Pl. Jurass., Vol. II, p. 284.

Purbeck beds, Isle of Portland, Dorsetshire, England. Morris gives as locality for *Strobilites Bucklandii*, not stated by Lindley and Hutton, the Upper Greensand of Wiltshire, and Presl says that the species is also found in the Lower Lias of Lyme Regis.

Cycadeoidea pygmæa L. & H.

1835. Cycadeoidea pygmæa L. & H., Foss. Fl. Gt. Brit., Vol. II, p. 175, pl. cxliii.
1841. Zamites pygmæus (L. & H.) Morris, Ann. and Mag. Nat. Hist., Vol. VII, p. 116.
1849. Echinostipes pygmæus (L. & H.) Pomel, Matériaux, etc., p. 17.
1870. Mantellia pygmæa (L. & H.) Carruthers, Trans. Linn. Soc. Lond., Vol. XXVI, p. 703.

Lower Lias of Lyme Regis, England. Pomel thought he recognized the species in his material from France, but this may have been *C. Pictaviensis*.

Cycadeoidea Saxbyana (R. Brown) Morris.

1851. Cycadites Saxbyanus R. Brown, Proc. Linn. Soc. Lond., Vol. II, p., 130.
1854. Cycadeoidea Saxbyana (R. Brown) Morris, Cat. Brit. Foss., 2d ed., p. 7.
1867. Bennettites Saxbyi Carruthers, Brit. Assoc. Rep., 37th Meeting, Pt. II, p. 80.
1870. Bennettites Saxbyanus (R. Brown) Carruthers, Trans. Linn. Soc. Lond., Vol. XXVI, pp. 681, 698, 706, pl. lvii, figs. 1–8.

Wealden of Brook Point, Isle of Wight, England.

Cycadeoidea Gibsoni Carruthers sp.

1867. Bennettites Gibsoni Carr., Brit. Assoc. Rep., 37th meeting, Pt. II, p. 80.
1870. Bennettites Gibsonianus Carr., Trans. Linn. Soc. Lond., Vol. XXVI, pp. 681, 700, pl. lviii, figs. 1-5; pl. lix, figs. 1-9; pl. lx. figs. 1-12.

Lower Greensand of Luccomb Chine, Isle of Wight, England.

Cycadeoidea Portlandica (Carr.) Solms.

1870. Bennettites Portlandicus Carr., Trans. Linn. Soc. Lond., Vol. XXVI, pp. 681, 700, 707, pl. lxi, figs. 1-5.
1892. Cycadeoidea Portlandica (Carr.) Solms, Mem. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, p. 187.

Lower Purbeck beds, Isle of Portland, England.

Cycadeoidea maxima (Carr.) Solms.

1870. Bennettites maximus Carruthers, Trans. Linn. Soc. Lond., Vol. XXVI, pp. 681, 699.
1892. Cycadeoidea maxima (Carr.) Solms, Mem. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, p. 187.

Wealden of Shanklin, Isle of Wight, England.

Cycadeoidea Carruthersi.

1870. Mantellia intermedia Carruthers, Trans. Linn. Soc. Lond., Vol. XXVI, pp. 681, 702, 708, pl. lxiii, figs. 4, 5.
1874. Cycadeoidea intermedia (Carr.) Schimp. (non Ranzani), Paléontologie Végétale, Vol. III, p. 556.

Lower Purbeck beds, Isle of Portland, England.

The name *C. intermedia* being preoccupied by Ranzani in 1836 (see below) it was necessary to change it.

Cycadeoidea Peachii (Carr.) Solms.

1867. Bennettites Peachii Carruthers, Brit. Assoc. Rep., 37th meeting, Pt. II, p. 80.
1870. Bennettites Peachianus Carruthers, Trans. Linn. Soc. Lond., Vol. XXVI, pp. 681, 700, 707, pl. lxii, figs. 1, 2.
1892. Cycadeoidea Peachii (Carr.) Solms, Mem. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, p. 187.

Coral Rag of Helmsdale, Sutherlandshire, Scotland.

Cycadeoidea inclusa (Carr.) Schimper.

1870. Mantellia inclusa Carruthers, Trans. Linn. Soc. Lond., Vol. XXVI, pp. 681, 703, 708, pl. lxiii, figs. 2, 3.
1874. Cycadeoidea inclusa (Carr.) Schimper, Paléontologie Végétale, Vol. III, p. 556.

Lower Cretaceous of Potton, Cambridgeshire, England.

Cycadeoidea Bucklandi Corda sp.

1845. Zamites Bucklandi Corda, Beitr. z. Flora der Vorwelt, pp. 38, 120, pl. xvii, figs. 1–10.

Locality and formation unknown. Corda says that the specimen probably came from England. It resembles *C. Saxbyana.*

Cycadeoidea Morieri Renault sp.

1887. Clathropodium Morieri Renault, Bull. Soc. Linn. Normand., 4e Sér., Vol. I, pp. 143–151, pl. iv, v.

Purbeck beds, Isle of Portland, England.

Cycadeoidea forata (Sap.) Solms.

1875. Clathropodium foratum Saporta, Pl. Jurass., Vol. II, p. 297, pl. cxxiv, figs. 1, 2.

1892. Cycadeoidea forata (Sap.) Solms, Mem. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, p. 190.

Gault of Cauville near Havre, France. Saporta's original supposition that this form came from the Oolite of Mans (Sarthe) was subsequently found to be erroneous.

Cycadeoidea Pictaviensis (Longuemar) Saporta, ms.

1870. Cycadeoidea Pictaviensis (Longuemar) Saporta, ms., in Schimper: Paléontologie Végétale, Vol. II, p. 188; Atlas, pl. lxxi, fig. 12.

1870. Araucaria Pictaviensis Longuemar, Et. géol. et agron. sur le depart. de la Vienne, Vol. I, p. 491.

1874. Bolbopodium Pictaviense (Longuemar) Saporta, Pl. Jurass., Vol. II, p. 258, pl. cxviii, fig. 2.

Upper Oxford of Montanaise near Poitier (Vienne), France.

Cycadeoidea Sarlatensis Saporta sp.

1849. Cycadeoidea sp. Brongniart, Tableau, p. 59.

1875. Clathropodium Sarlatense Saporta, Pl. Jurass., Vol., II, p. 293, pl. cxxiii, figs. 1, 2.

Upper Jurassic of Sarlat (Dordogne), France.

Cycadeoidea Trigeri Brongniart.

1849. Cycadeoidea Trigeri Brongniart, Tableau, p. 59.

1849. Cycadites Trigeri Brongn. ms., cf. Saporta, Pl. Jurass., Vol. II, p. 288.

1849. Echinostipes sp. Pomel, Matériaux, p. 17.

1874. Clathropodium Trigeri (Brongn.) Saporta, Pl. Jurass., Vol. II, p. 288, pl. cxxii, figs. 1–3.

Upper Jurassic of Mans (Sarthe), France.

Cycadeoidea micromera Saporta sp.

1874. Bolbopodium micromerum Saporta, Pl. Jurass., Vol. II, p. 262, pl. cxviii, fig. 1.

Corallian of Tonnerre (Yonne), France.

Cycadeoidea Mamertina Crié sp.

1879. Bolbopodium Mamertinum Crié, Les Anciens Climats et les Flores Fossiles de l'Ouest de la France, pp. 15, 18.

Bathonian of Mamers (Sarthe), France.

Cycadeoidea Montiana Capellini & Solms.

1755. Lapideorum balanorum insignis congeries Monti, Bonon. Sci. et Art. Inst. at. Acad. Comment., Tom. III, p. 323, tav. fol.

1892. Cycadeoidea Montiana Capellini & Solms, Mem. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 169, 181, 214, pl. iii, fig. 1.

Rio della Cavaliera, Bolognese, Italy. Cretaceous?

Cycadeoidea intermedia Ranzani.

1836. Cycadeoidea intermedia Ranzani, Resoconto Accad. Ist. di Bologna, 23a Sess., 26 maggio 1836.
1839. Nov. Com. Acad. Sci. Inst. Bonon., Tom III (Bull. Sci. Med., Vol. I), p. 385, tab., figs. 2, 3, 5.

Fiume Reno, Bolognese, Italy. Cretaceous?

Cycadeoidea Scarabellii (Mgh.) Cap. & Solms.

1854. Mantellia? Scarabellii Meneghini, Ann. dell Università Toscana, Tom. III, p. 74, nota 14.
1892. Cycadeoidea Scarabellii (Mgh.) Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom, II, pp. 170, 171, 176, 181, 207, 214, pl. iii, fig. 3.

Fiume Santerno, Imolese, Italy. Cretaceous? Meneghini maintained that this species belonged to the Miocene in which it was found, but Capellini does not doubt that, like most of the other Cycadean trunks of Italy, it was redeposited from the argillaceous shales of the underlying Cretaceous.

Cycadeoidea Pirazzoliana Massalongo, ms.

1858. Cycadeoidea Pirazzoliana Massalongo, ms.
1892. Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 171, 176, 181, 208, 212, pl. ii, fig. 1.

Torrente Correcchio, Imolese, Italy. Cretaceous?

Cycadeoidea Veronensis Massalongo.

1858. Cycadeoidea Veronensis Massalongo, Atti d. R. Ist. Veneto, Ser. 3a, Tom. III, Venezia, p. 816.
1859. Syllabus Pl. Foss. Agri Veneti, pp. 20, 132.
1892. Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 173, 181, 206.

In the garden Feruzzi-Malagnini, wall of the Padri in Verona, artificially so placed. Original source unknown. The specimen was discovered in this position by Massalongo and Scarbelli in 1858 mingled with stalactites and other objects. Capellini states that it was not mentioned in print until 1859 in the *Syllabus* on page 20, and seems not to have been aware that Massalongo embodied it under the same name in his "Elenco dei modelli di piante fossili donati al R. Istituto Veneto," published in 1858 in the Atti, Ser. 3, Tom. III, on page 816. He also includes it, along with *C. Bianconiana*, in the "Elenchus Specierum Vegetalium et Animalium Fossilium," etc., placed at the end of the *Syllabus* (see p. 132).

Cycadeoidea Bianconiana Massalongo.

1859. Cycadeoidea Bianconiana Massalongo, Syllabus Pl. Foss. Agri. Veneti, p. 132.
1892. Mem. Real. Accad. Sci., Ist. Bologna, Ser, V, Tom. II, pp. 172, 181, 205, pl. ii, fig. 2.

Torrente Samoggia, Bolognese, Italy. Cretaceous? Capellini seems not to have observed Massalongo's record of this plant in his *Syllabus*, p. 132. He there says: "Ex form. ignota agri Bononiensis. Caudex."

Cycadeoidea Cocchiana (Caruel) Solms.

1870. Raumeria Cocchiana Caruel, R. Com. Geol. Ital. Bol., Vol. I, pp. 183, 186; figs. on p. 186.

1892. Cycadeoidea Cocchiana (Caruel) Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 174, 181, 206, 215, pl. v, figs. 2, 5.

Torrente Marnia in Valdarno, Italy. Cretaceous? The specimens were found erratic in the Pliocene.

Cycadeoidea Maraniana (Scarab.) Solms.

1875. Bennettites Maranianus Scarabelli, ms.

1892. Cycadeoidea Maraniana (Scarab.) Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 176, 179, 181, 201, 212, 214, pl. ii, fig. 3; pl. iii, fig. 4.

Castel S. Pietro and Torrente Correcchio, Imolese, Italy. Createaceous?

Cycadeoidea Capelliniana Solms.

1879. Cycadacea specie Ferreti, Atti Soc. Ital. Sci. Nat., Vol. XXI. p. 832.

1892. Cycadeoidea Capelliniana Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 174, 181, 207, 212, 214, 215, pl. i, figs. 3, 4; pl. v, figs. 1, 3, 6.

Fiume Idice, Bolognese; Torrente Tresinaro presso Scandiano; Paullo nel Regiano; Vallestra, Regiano, Italy. Cretaceous?

Cycadeoidea Masseiana Cap. & Solms.

1890. Raumeria Masseiana Capellini, Mem. Real. Accad. Sci. Ist. Bologna, Ser. IV, Tom. X, pp. 446, 450, pl. ii.

1892. Cycadeoidea Masseiana Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 165, 168, 175, 178, 181, 205, 212, pl. i, fig. 1.

Cretaceous (Cenomanian?) clay shales of the Idice Valley, near the Villa di Ozzano in Emilia, Italy.

Cycadeoidea Etrusca Cap. & Solms.

1892. Cycadeoidea Etrusca Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 177, 181, 204, 212, 214, 215, pl. i, fig. 2; pl. iv, fig. 1; pl. v, figs. 7, 8.

Etruscan Necropolis of Marzabotto, Bolognese, Italy. Cretaceous? Original source unknown. Specimen found placed on a tomb as an ornament or symbolic rite by the ancient inhabitants. It is the largest of the Italian specimens.

Cycadeoidea Ferretiana Cap. & Solms.

1892. Cycadeoidea Ferretiana Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 178, 181, 209.

Monte Babbio, Regiano, Italy. Cretaceous?

Cycadeoidea Imolensis Cap. & Solms sp.

1892. Cycadea Imolensis Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 176, 181, 200.

Fiume Santerno? Imolese, Italy. Cretaceous?

I have not hesitated to place this species in the genus Cycadeoidea because Count Solms gives as his only reason for not doing so that the specimen was too imperfect to be certain that it belonged there. He therefore created a new genus (Cycadea) for its reception. Such a course is certain to lead to great confusion. New genera should only be created where the material is so abundant and complete that it can be adequately characterized. This new genus is not even described, and as he admits, could not be from his specimen. It therefore can have no existence. On the other hand the large number of specimens found in Italy, all referable to Cycadeoidea make it altogether probable that this also belongs there. The only other course would be to hold it entirely in reserve. This he has not done but has given it a specific name.

Cycadeoidea sp. indet. Cap. & Solms.

1892. Cycadeoidea sp. indet. Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 176, 181.

Fiume Santerno? Imolese, Italy. Cretaceous?

Cycadeoidea Reichenbachiana (Göpp.) Cap. & Solms.

1755. Vegetabilische Versteinerung Walch, Knorr's Petrefacten Sammlung, Text, p. 150; Atlas, pl. iiia, fig. 6.
1844. Raumeria Reichenbachiana Göppert, in Wimmer: Flora von Schlesien, Ed. II, Vol. II, p. 217.
1853. Jubiläums-Denkschr. d. Schles. Ges. f. vat. Cult., 1853, pp. 262, 265, pl. viii, figs. 4-7; pl. ix, fig. 1.
1892. Cycadeoidea Reichenbachiana (Göpp.) Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 186, 187, 188.

Lednice near Wieliczka, Galicia. This is the large and now celebrated specimen in the Dresden Museum. Its geologic age is still unknown, but is almost certainly not Permian as conjectured by Geinitz.

Cycadeoidea Schulziana (Göpp.) Cap. & Solms.

1844. Raumeria Schulziana Göppert, in Wimmer: Flora von Schlesien, Ed. II, Vol. II, p. 217.
1853. Jubiläums-Denkschr. d. Schles. Ges. f. vat. Cult., 1853, pp. 259, 264, pl. vii, figs. 1-5; pl. viii, figs. 1-3.
1892. Cycadeoidea Schulziana (Göpp.) Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 186, 187.

Klodnitz Canal near Gleiwitz, Silesia; formation unknown.

Cycadeoidea Schachti (Coem.) Cap. & Solms.

1867. Cycadites Schachti Coemans, Mem. Cour. des Savants Etrangers de l'Acad. Roy. de Belgique, Vol. XXXIII, No. 3, p. 7, pl. iii, figs. 1, 2, 5.
1870. Clathraria Schachti (Coem.) Schimper, Paléontologie Végétale, Vol. II, p. 212.
1870. Bennettites Schachti (Coem.) Carruthers, Trans. Linn. Soc. Lond., Vol. XXVI, p. 699.
1892. Cycadeoidea Schachti (Coem.) Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, p. 187.

Gault of La Louvière, Hainaut, Belgium.

Cycadeoidea Marylandica (Font.) Cap. & Solms.

1860. Cycas sp. Tyson, First Report State Agric. Chem. Maryland, p. 42.
1870. Bennettites sp. Carruthers, Trans. Linn. Soc. Lond., Vol. XXVI, p. 708.
1879. Cycadeoidea sp. Fontaine, Am. Journ. Sci. 3d Ser., Vol. XVII, p. 157.
1889. Tysonia Marylandica Fontaine, Flora of the Potomac Formation, p. 193, pl. clxxiv–clxxx.
1892. Cycadeoidea Marylandica (Font.) Cap. & Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 179, 180, 186.

Potomac formation (Lower Cretaceous) at various points in Maryland, chiefly along the Baltimore and Ohio Railroad between Washington and Baltimore and in the vicinity of the latter city.

Cycadeoidea Emmonsi Font. sp.

1857. Trunk of a cycad Emmons, American Geology, Vol. VI, pp. 123, 124; fig. 92a.
1883. Zamiostrobus Emmonsi Fontaine, Older Mesozoic Flora, p. 117, pl. lii, fig. 5.

Upper Trias of North Carolina, exact locality not known.

Judging from the excellent figure of Dr. Emmons, of which that of Professor Fontaine is not a true reproduction, I consider it much more probable that this was a "trunk of a cycad" than that it was a strobile.

Cycadeoidea mirabilis Lx. sp.

1876. Zamiostrobus mirabilis Lx., Bull. U. S. Geol. and Geogr. Surv. Terr., Vol. 1, 2d Ser., No. 5, p. 383 (issued January 8, 1876); Hayden's Ann. Rep. U. S. Geol. and Geogr. Surv. Terr. for 1874, p. 309.
1878. Tertiary Flora, p. 70, pl. lxiii, figs. 1, 1a.
1884. Nelumbium sp. James. Science, Vol. III, p. 434.
1884. Clathropodium mirabilie (Lx.) Ward, Science, Vol. III, pp. 532 533.
1890. Bennettites mirabilis (Lx.) Solms, in litt. (Sept. 10).
1892. Cycadeoidea Zamiostrobus Solms, Mem. Real. Accad. Sci. Ist. Bologna, Ser. V, Tom. II, pp. 210, 211.

Found lying on the surface of the ground near Golden, Colorado, in the Laramie terrane, but probably belonging to a more ancient formation from which it had been transported.

Cycadeoidea munita Cragin.

1889. Cycadeoidea munita Cragin, Bull. Washburn College Lab. Nat. Hist., Topeka, Kansas, Vol. II, No. 10, pp. 65, 66.

Cheyenne Sandstone, Trinity Division of the Comanche Series (Lower Cretaceous), at Cheyenne Rock, Belvidere, Southern Kansas.

Cycadeoidea Dacotensis McBride sp.

1893. Bennettites Dacotensis McBride, American Geologist, Vol. XII, p. 249, pl. xi, figs. 1, 2; Bull. Lab. Nat. Hist. State Univ. of Iowa, Vol. II, No. 4, p. 391, pl. xii, figs. 1, 2.

Lower Cretaceous strata, valley of Minnekahta Creek near Minnekahta Station of the Burlington and Missouri Railroad, Fall River County, South Dakota (Black Hills).

Cycadeoidea Jenneyana n. sp.

Trunks cylindrical-conical, 15 to 17 inches in diameter and 2 to 3 feet high with concave depression ("crow's nest") at the summit; cross section of leaf stalks very irregular, rhombic or trapezoidal, two of the angles often very acute or prolonged indicating wings, the other angles obtuse.

Divide between Box Elder Creek and Elk Creek, six or eight miles north of Rapid City, South Dakota (Black Hills). Formation not yet determined but probably same as last.

The above description and data as to location are taken from letters received from Prof. W. P. Jenney, Dean of the Faculty of the State School of Mines at Rapid City where the specimens now are. There are two specimens, one of which shows the summit but lacks the basal portion and is 21 inches high and 15 inches in diameter at the lower end. The other shows the base but not the summit, is 17 inches in diameter and quite cylindrical, but truncated at the height of 16 inches. This form clearly indicates that the species at least is distinct from the last and it is possible that when better material is discovered it may require to be referred to some of the less dwarfted genera, such as Bucklandia or Cylindropodium. The distinction is further emphasized by the difference in the shape of the leaf bases or perforations left by their disappearance. I have named the species for Professor Jenney to whose assistance I am so greatly indebted in determining the geological position of the fossil plant beds in the southern portion of the Cretaceous rim of the Black Hills, a region which scientifically he has made his own.

Cycadeoidea Abequidensis Dawson.

1871. Cycadeoidea Abequidensis Dawson, Geol. Struct. Prince Edward Island, p. 45, pl. iii, fig. 29.

Trias of Gallas Point, Prince Edward Island. Sir Wm. Dawson referred this deposit doubtfully to the Lower Trias, but some regard it as the equivalent of the Newark System.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

NOTE ON SOME APPENDAGES OF THE TRILOBITES,

BY CHAS. D. WALCOTT.

The results of Mr. W. S. Valiant's long search for the appendages of trilobites have recently been made known by Mr. W. B. Matthew, who described the material sold to the Columbia College of New York by Mr. Valiant.* Mr. Valiant informs me that he discovered traces of what he considered to be antennæ, and that for several years he continued collecting until he found a locality where the specimens were well preserved and show, not only the antennæ, but legs and what he supposed to be the swimming appendages. Not having confidence that he could properly describe the specimens he sold part of his material, and in this way it came to be first described by Mr. Matthew, a student at Columbia College. His step-brother, Mr. Mitchell, continued to collect; and in August, 1893, through the courtesy of Mr. Valiant, I visited the locality with Mr. Mitchell and obtained a few specimens for the National Government.

The most important part of the discovery, announced by Mr. Matthew's paper, is that the trilobita have true antennæ. The discovery of the legs and plumose appendages is also of great interest, as it adds to our information respecting the appendages of the trilobite some of the details of another genus.

A collection was made for the Yale College Museum by Dr.

Read March 24, 1894.

*Am. Jour. Sci., Vol. 46, 1893, p. 121.

C. E. Beecher, and in some notes on the thoracic legs of Triarthrus* he describes and illustrates a dorsal view of the legs of the second and third free thoracic segments. These show that the endopodite of the leg is essentially the same as in Calymene and Asaphus, and that the exopodite is unlike that of Calymene or Ceraurus.

Through the courtesy of Prof. J. F. Kemp of Columbia College, I have examined the material studied by Mr. Matthew; and Prof. A. H. Chester, of Rutgers College, kindly loaned me for study five specimens that he purchased from Mr. Valiant. From these and the specimens in the National Museum a few notes have been taken that permit of some comparisons with the extremities found in Ceraurus, Calymene and Asaphus.† The limbs of Triarthrus differ in the details of the joints of the inner branch of the limb (endopodite) and still more in the character of the exopodite.

Cephalic limbs.—The antennæ are uniramose, and, judging from the position in which they are found, were attached to the body near the postero-lateral angle of the hypostoma (Fig. 1, *e*, Plate 1). In one specimen a cephalic limb somewhat detached from its true position shows a large basal joint and six slender joints (Fig. 1, *f*). The basal joint does not show conclusive evidence of the presence of a masticatory ridge. On another specimen, however, the form of the basal joint strongly suggests that it subserves the purpose of mastication. This is illustrated at *g* in Fig. 1.

A slender jointed appendage like that attached to the basal joint of *g* occurs between it and the antennæ and is probably a portion of another one of the cephalic limbs. No other cephalic appendages have been observed in the material at hand.

Since the publication of my articles on The Trilobite‡ I found in a section of the head of *Calymene senaria* a slender jointed limb that appears to have been an antennule. It is unlike any limb found beneath the head and thorax, and, if not an antennule, it may represent a fifth pair of cephalic limbs. This is also suggested by a section of the limbs within the head of Calymene, illustrated on Plate 1, Fig. 9, Bull. Mus. Comp. Zool., Vol. 8, 1881. In this, a fifth limb is indicated close to the hypostoma. The trilobite was enrolled so as to include the antennule entirely within the border of the head. A sketch, taken from a photograph of the thin section by transmitted light, is shown by Fig. 8, Pl. 1.

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*Am. Jour. Sci., Vol. 46, 1893, pp. 467-470.

†The Trilobite; New and Old Evidence Relating to its Organization. Bull. Mus. Comp. Zool., Vol. 8, 1881, p. 6.

‡Bull. Mus. Comp. Zool., Vol. 8, 1881, p. 191-224. Science, Vol. 3, 1883, p, 279.

The hypostoma of Ceraurus* shows a rounded indentation of the antero-lateral sides, where an antennule probably passed by it. This character is strongly marked in *Sao hirsuta, Proetus bohemicus, Amphion fischeri,* etc., as illustrated by Barande.

The character and position of the remaining cephalic limbs of Triarthrus are not shown in any specimens that I have examined, but, from the relations of Calymene, Ceraurus and Triarthrus, especially the two latter, it is probable that their arrangement is essentially the same.

Thoracic limbs.—Many specimens show the thoracic limbs extending out from beneath the carapace of Triarthrus. It was not until by a fortunate dissection that I obtained the material illustrating the limbs in position beneath the thorax. The anterior limbs are formed of a protopodite and a somewhat complex exopodite. The protopodite consists of a short basal and a long joint, (Fig. 2, *d*, *e*,) to which the endopodite and exopodite are attached. This appears to be direct in the posterior limbs of the thorax (Fig. 3, *a*), but as yet the point of attachment of the basal joint of the exopodite has not been seen in the anterior limbs.

The endopodite of the anterior portion of the thoracic limbs varies in the number of joints and in their relative length (Fig. 1, *a*, *a*). Two show four long proximal and three shorter distal joints. Other limbs show two smaller distal, and three or four proximal, while in several there is a more or less uniform gradation from the protopodite to the distal joint. In Fig. 1, some of these variations are indicated. In Fig. 2, eleven limbs are shown, as seen from the under side. The basal (coxal) joint is seen at *b*, *d*, *e*, and nine show the long second joint of the protopodite. At *e* and *f* a new phase is indicated by the enlargement of the proximal joints. This is marked in *a*, *b*, *c*, *d*, and in Fig. 3, the details are more fully shown. These joints occur

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*Loc. cit., Pl. iv., Fig. 5.

on the seven posterior thoracic limbs of Fig. 2; and in the specimen from which Fig. 3 was drawn the limb opposite the tenth segment from the pygidium shows a slightly triangular *second* (meropodite) and *third* (carpodite) joint. In Fig. 2, the limb *a* is opposite the second free segment of the thorax anterior to the pygidum. The limbs *a* and *b*, Fig. 3, clearly show that the four proximal joints are broad and subtriangler in outline. A glance at the abdominal swimming legs of the Phyllocarida (Paranebalia), Schizopoda and Cumacea, suggests that the functions of these legs were both natatory and ambulatory.

The expododite illustrated by Beecher shows the dorsal surface (Fig. 6). A number, presenting the ventral surface, are shown on the right side of Fig. 2. They occur on the same specimen as the endopodities, on the left side, but have been pushed out of place. The most perfect is represented by *m*. The proximal portion is formed of a rather large basal joint and a number of short joints, 7 or 8. The distal end is formed of an inner and outer segmented portion. The inner side is divided into numerous segments by oblique divisions that give the impression of a closely coiled spiral. The outer side is a cylindrical, jointed, stem-like rim that is attached to the inner side, a narrow, distinctly impressed line separating the two, except at the somewhat flattened tip where they merge into each other. On the outer or upper surface of the outer side numerous crenulations occur that extend into long setæ, *n*, Fig. 2; *b*, *b*, Fig. 1. Dr. Beecher considers the expodite as a swimming organ; but from the manifest branchial character of the exopodite and attached epipodite in Calymene (Fig. 7), it seems probable that this exopodite of Triarthrus served largely as a gill, and that the animal used the broad proximal joints of the posterior limbs of the thorax as its principal propulsion in swimming. The exopodite of Triarthrus looks like a consolidated exopodite and epipodite, very much as though these two organs as they occur in Calymene were merged into one.

Several specimens illustrate appendages beneath the pygidium. Some have the broad proximal joints, *d*, Fig. 1, while others show the outer rim of the exopodite *c*, Fig. 1. The material I have seen indicates very little difference between the appendages of the posterior half of the thorax and the pygidium, except that those of the latter are less developed in size and details.

Mr. Matthew suspected the presence of a flap, formed by the anchylosing of the appendages beneath the pygidium. From the appearance of a similar structure, where the limbs are matted together along the side of the thorax, this tentative view is received with doubt. More perfect material may show distinctions not recognizable at present.

If future investigations prove, as it now seems probable, that the modified swimming joints of the endopodite are attached to ten or more of the thoracic segments, the anterior eight segments can be grouped together as the typical thorax, and the remaining segments of the body as the abdomen.

Mr. Matthew suggests that the homology between Triarthrus and Limulus may not be as close as between Limulus, Calymene and Ceraurus. This is true from what we now know of Triarthrus, but, if a sixth pair of cephalic limbs should be discovered in Triarthrus the resemblance would be strengthened. Triarthrus does not differ from Ceraurus and Calymene more than would be anticipated in such unlike genera. Triarthrus is essentially a "Primordial" type that has continued until upper Ordovician time. It represents a large group of Cambrian trilobites, while Calymene and Asaphus represent the more highly developed Ordovician and Silurian forms.

Dr. Lang held the view that if a fifth pair of cephalic limbs were found, comparable to the anterior antennæ "Trilobites might then be regarded as original *Entomostraca,* to be derived from the same racial form as the Phyllopoda." He says further, "Xiphosura, Hemiaspidæ, and Gigantostraca are themselves again perhaps racially connected with the *Trilobites.* In any case, however, in the present state of science, it seems probable that all these groups are only connected at their roots with the Crustacea.*"

From the paleontological record I am essentially in accord with this view, but I am not yet prepared to abandon the position taken in 1881, that all these groups should be arranged under one class and not as an appendage to the Crustacea, as proposed by Dr. Lang.

Text Book of Comparative Anatomy, Eng. Ed., 1891, p. 415.

*Loc. cit., p. 421.

I would go still further and form a class of the *Trilobita* and one of the Merostomata.

Two general facts lead me to think that the modern crustacean is descendant from the Phyllopod branch and the Trilobita from a distinct branch.* 1st. The Trilobita branch exhausted its initial vital energy in Paleozoic time and disappeared. 2nd. The Phyllopod branch developed slowly until after the Trilobita passed its maximum and then began its great differentiation that approaches culmination in recent times.

When the trilobite and phyllopod diverged from their common ancestral crustacean the trilobite began at once to differentiate and to use its initial vital energy in developing new species, genera and families. Probably two thousand species and one hundred or more genera are known from the Paleozoic strata. With this great differentiation the initial vital energy was impaired and the Trilobita died out at the close of Paleozoic time.

The Phyllopod branch continued with little variation until after the trilobite passed its maximum, and then began to differentiate until to-day its descendents form the class Crustacea, that corresponds to the class Trilobita in Paleozoic time. Springing from a common crustacean base the two groups have many features in common, and in carrying out of details of structure in the limbs and gills many striking resemblances occur. It does not impress me that trilobites were true Entomostracans or Malacostracans; they have certain characteristics in common, but these are not necessarily the result of lineal descent one from the other but are the result of descent from a common ancestral crustacean type of pre-Cambrian time that lived in the pelagic fauna in which all the earlier types of life were probably developed† and from which, as time passed on, additions must have been made to the paleontologic record of geologic time. The Phyllopods, Ostracods and Trilobita are clearly differentiated in the lower Cambrian fauna. Bernard is confidant that the Trilobites may take a firm place at the root of the Crustacean system, with the existing Apus as their nearest ally.*

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*This view is only confirmatory of the result of the profound study of the Apodidæ by Bernard (The Apodidæ Nature Series, 1892).

†See Brooks' beautiful memoir on Salpa, with its suggestive theory of the origin of the bottom faunas of the ocean and the early geologic faunas. The Genus Salpa, Memoirs from the Biological Laboratory of the Johns Hopkins University, II, 1893, pp. 140–177.

There is yet much to be learned from the study of Triarthrus. A great amount of material can be readily collected at the locality near Rome, N. Y. It is also of interest to note that the locality at Trenton Falls, N. Y., from which the specimens of Calymene and Ceraurus were obtained, is only seventeen miles from the Rome locality; that both occur within the Ordovician; and that the stratigraphic position of the bed at Rome is between six and seven hundred feet above that at Trenton Falls.†

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*Nature, Vol. 48, 1893, p. 582.

†The appendages of Triarthrus are replaced by iron pyrites and are usually well preserved. The specimens of Calymene and Ceraurus from the Trenton limestone of Trenton Falls, N. Y., were replaced by calcite and in them there were preserved even more delicate parts than I have yet observed in Triarthrus. Thin sections were made of the latter and photographs obtained by transmitted light, that were used in illustrating the paper in the Bulletin of the Museum of Comparative Zoology, Vol. 8, 1881.

Description of Plate.

Fig. 1.—*Triarthrus becki* (X3). Outline of carapace, with appendages represented as they occur on several specimens, their relative position being retained.

a, a, a, a. Endopodites of limbs showing variation in joints.
b, b. Plumose portion of exopodite.
c, c. The outer or supporting portion of the setæ or fimbriæ of *b, b.*
d. Limbs extending from beneath the pygidium, showing large proximal joints. Those of the left side are imperfectly preserved.
e. Antenna extending back nearly to the postero-lateral margin of the hypostoma.
f. One of the cephalic limbs. The basal joint may be broken away on the inner side.
g. Cephalic limb.

Fig. 2 (X7). Limbs attached to the under surface of an individual preserving 13 thoracic segments and the pygidium. The limbs (*a* to *k*) on the left side are mainly in place. A fracture cuts out one limb between *g* and *h*.

a to *g.* Limbs preserving traces of the enlarged proximal joints.
b, d. Limbs preserving the two joints of the protopodite and two of the large proximal joints.
l, m, o. Exopodites, showing under or side views.
n. Enlargement of fimbriæ of *m.*
r, s. Distal joints of endopodites of right side.
y. Portion of an exopodite showing its inner support.

Fig. 3. Limbs occurring on the under side of an individual of 14 thoracic segments.

a, b, c, d. Limbs with flattened, enlarged proximal joints and slender distal joints.
a. Limb preserving large joint of protopodite, four enlarged proximal joints and three slender distal joints. At *x* the point of attachment of an exopodite is shown, and in the specimen it looks as though *f* had been broken away from *x*.

Fig. 4. Restoration of the thoracic limbs of the fifth segment anterior to the pygidium.

en. endopodite. p. protopodite. a. four proximal swimming joints. b. three distal joints.
ex. exopodite, attached to same joint of the protopodite as the endopodite.

Fig. 5. Restoration of the thoracic limbs of the fourth thoracic segment posterior to the head.
en. endopodite. *ex.* exopodite.

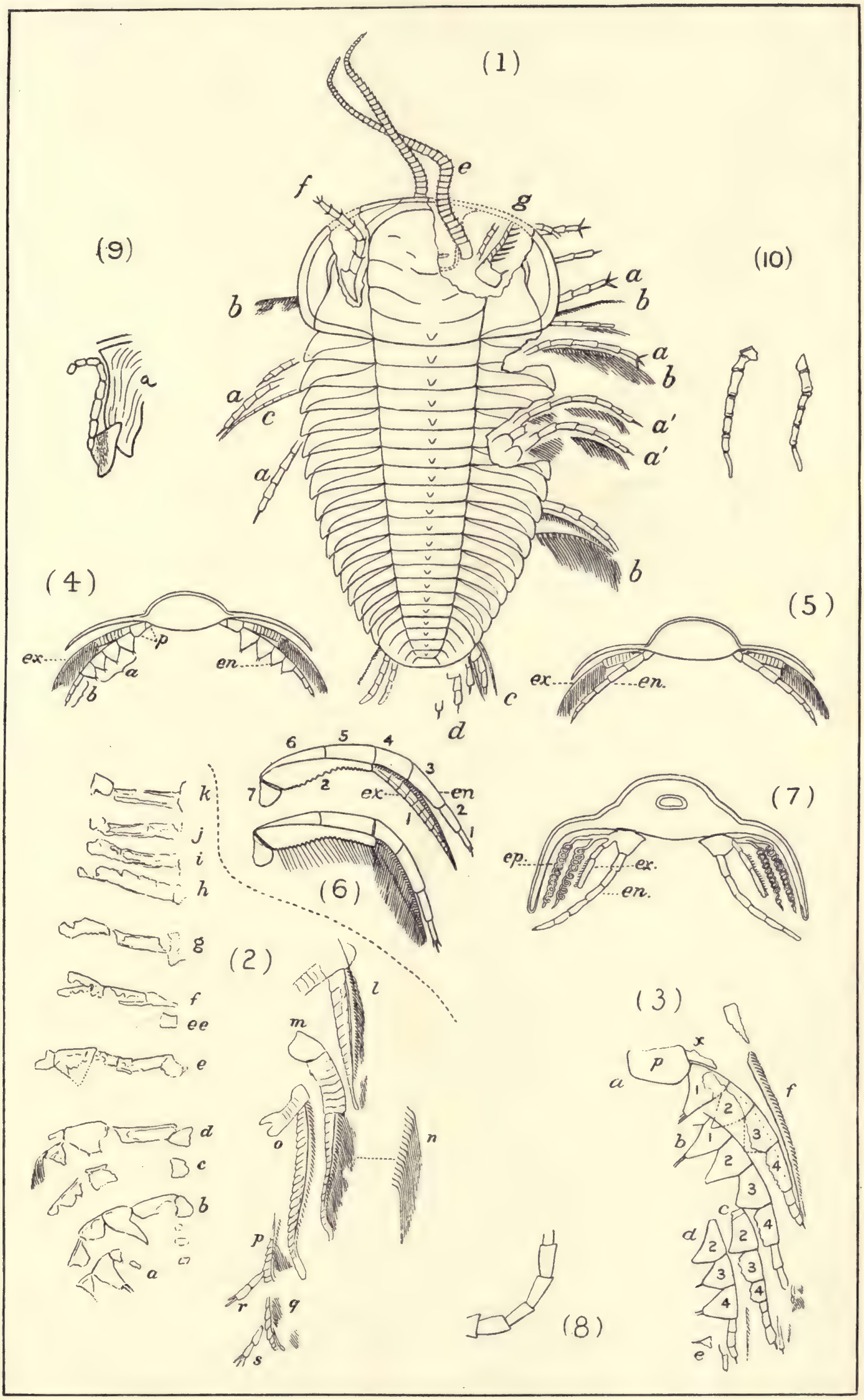
Fig. 6. Diagramatic restoration of the second thoracic limb. (After Beecher.)

Fig. 7. Restoration of thoracic limb of *Calymene senaria.*
en. endopodite. *ex.* exopodite. *ep.* epipodite. (Bull. Mus. Comp. Zool. Vol. 8, 1881.)

Fig. 8. Cephalic limb of Calymene X 3; supposed antennule.

Fig. 9. Cephalic limb figured by Dr. Henry Woodward. (Quart. Jour. Geol. Soc. London. Vol. 26, 1870, p. 487. a. side of hypostoma.

Fig. 10. Slender jointed legs associated in same beds with Calymene at Cincinnati, Ohio.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VOL. IX, PP. 99-104 APRIL 14, 1894

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

SYNAPTOMYS COOPERII BAIRD IN EASTERN MASSACHUSSETTS; WITH NOTES ON SYNAPTOMYS STONEI RHOADS, ESPECIALLY AS TO THE VALIDITY OF THIS SPECIES.

BY OUTRAM BANGS, BOSTON, MASS.

Ever since I began to trap small mammals in the modern improved manner, I have been on the lookout for this species and so was not surprised to find, on June 9th, 1893, a fine adult female in one of my traps. The trap was set in an old cranberry bog that had been allowed to run out, and had grown up to clumps of Viburnum and Vaccinium bushes, and under these, grasses and sphagnum and carices had crowded out the cranberry vines to a considerable extent. It was in the middle of the Plymouth woods, about seven miles from the town of Wareham, Plymouth County, Mass. The ground was traversed in every direction by the run-ways of *Arvicola riparius* and in one of these run-ways I caught the *Synaptomys*. She was nursing young at the time, although repeated trapping in the same bog yielded nothing but innumerable *Arvicolas*, a *Zapus hudsonius* or two, and a few *Evotomys gapperi*.

I now had a slight notion of the sort of place to look for *Synaptomys* in, and tried all such localities I could find without success until September 21, 1893, when in an almost precisely similar bog about six miles distant from the first place, in the township of Wareham, I caught an adult female, also nursing, and in an *Arvicola* run-way; and on September 24, an adult male in another trap in the same bog, in an *Arvicola* run-way.

Following is a list of small mammals caught in this last bog, which, as I trapped it pretty clean, may be of interest as showing the species inhabiting such a place, and their relative abundance:

Twenty [20] traps set.

Sept. 19, 1893.	6 Arvicola riparius.
	1 Zapus hudsonius.
Sept. 20.	5 Arvicola riparius.
	1 Evotomys gapperi.
Sept. 21.	3 Arvicola riparius.
	1 Evotomys gapperi.
	1 Sorex personatus.
	1 Synaptomys cooperii.

Sixty-five [65] traps set.

Sept. 22.	17 Arvicola riparius.
	1 Evotomys gapperi.
Sept. 23.	10 Arvicola riparius.
Sept. 24.	6 Arvicola riparius.
	1 Evotomys gapperi.
	1 Synaptomys cooperii.
Sept. 25.	3 Arvicola riparius.
	1 Evotomys gapperi.
Sept. 26.	1 Arvicola riparius.
	1 Evotomys gapperi.
Sept. 27.	1 Evotomys gapperi.
Sept. 28.	Nothing; took up traps.
Totals.	Arvicola riparius, 54.
	Evotomys gapperi, 7.
	Sorex personatus, 1.
	Zapus hudsonius, 1.
	Synaptomys cooperii, 2.

This bog contained about an acre-and-a-half, and was bordered on one side by thick swampy woods and on the other three by open fields of grass, and had a small brook running through it.

Synaptomys cooperii is, I think, rare, or at any rate very local in this section, as I have trapped persistently for two years in every sort of locality the county affords, and have only taken these three examples.

As the country about Wareham, Mass., is not unlike that of

South Central New Jersey, I was anxious to see if my specimens were not referable to *S. stonei* Rhoads rather than to *S. cooperii.* For this purpose Dr. C. Hart Merriam kindly lent me a fine series of fourteen skins and many skulls of *S. cooperii*, partly from his own private collection, and partly from the collection of the Department of Agriculture at Washington. I also, through the kindness of Mr. S. N. Rhoads, of the Academy of Natural Sciences, Philadelphia, had a chance to examine his type of *Synaptomys stonei* and a topotype in the collection of Mr. Whitmer Stone, for whom the species was named.

In the light of this fine material, the specific character claimed for *S. stonei* faded away to mere individual variation, and *S. stonei* will have to stand as a synonym of *S. cooperii*, pure and simple.

The list of specimens I had to work with is as follows:

No.	Sex.	Date.	Locality.	Collector.	Measurement of hind foot.
*215	♀ad.	June 9, 1893	Mass., Wareham.	O. Bangs	19¶
216	♀ad.	Sept. 21, 1893	Mass., Wareham.	O. Bangs	18.5¶
217	♂ad.	Sept. 24, 1893	Mass., Wareham.	O. Bangs	19¶
†3137	♀	Feb. 22, 1887	Indiana, Brookville.	A. W. Butler	18.5¶
3189	♂	Mar. 7, 1887	Indiana, Brookville.	A. W. Butler	18.5¶
827	♂	Nov. 10, 1884	Iowa, Knoxville.	C. K. Cherie	17.5
2601	♂	Aug. 18, 1886	Minn., Elk River.	Vernon Bailey	17
3260	♂	Dec. 10, 1886	Minn., Elk River.	Vernon Bailey	18
3261	♂	Dec. 9, 1886	Minn., Elk River.	Vernon Bailey	17.5
3263	♀	Dec. 26, 1886	Minn., Elk River.	Vernon Bailey	18
3264	♀	Mar. 5, 1887	Minn., Elk River.	Vernon Bailey	17
‡33089		Mar. 4, 1889	Minn., Elk River.	N. Bailey	20¶
53811	♂	May 11, 1893	N. C., Magnetic City.		20
50863	♂	Oct. 23, 1892	N. C., Roan Mt., alt. 6200 ft.	Elmer Edson	18
50862	♂	Oct. 22, 1892	N. C., Roan Mt., alt. 6200 ft.	Elmer Edson	19
35615	♀	Sept. 30, 1892	N. C., Roan Mt., alt. 6200 ft.	Elmer Edson	19.5
55797	♂	Aug. 27, 1893	N. C., Roan Mt., alt. 6000 ft.	Elmer Edson	19
§576	♀	Dec. 2, 1892	N. J., May's Landing.	S. N. Rhoads	18¶
‖168	♂	Feb. 16, 1893	N. J., May's Landing.	W. Stone	20¶
6401	Skull	Mar. 24, 1890	Maryland, Sandy Springs.		

*Collection of E. A. & O. Bangs, Boston, Mass.

†Collection of Dr. C. Hart Merriam, Locust Grove, N. J.

‡Collection of U. S. Department of Agriculture, Washington, D. C.

§Collection of Sam'l N. Rhoads [type of S. Stonei].

‖Collection of Whitmer Stone [topotype of S. Stonei].

¶These measurements taken by collector from fresh animal; all the others were taken by me from dried skin.

Many of the specimens I had were unmeasured, and as the hind foot is the only measurement that can be taken with accuracy from the dried skins, I give this only [in millimetres].

The few that were measured show that there is no difference in size or proportion between *S. cooperii* and *S. stonei* and indeed Mr. Rhoads states himself that there is none.

Measurements of eight (8) skulls of *Synaptomys cooperii Baird.*	Minn., Elk River, Mar. 4, 1892. No. 45087*	Minn., Elk River, Aug. 18, 1886 ♂ No. 3230†	N. C., Roan Mt., Sept. 30, 1892 ♀ No. 47858*	Ind., Brookville, Feb. 17, 1887 ♀ No. 3771†	N. C., Magnetic City, May 11, '93 ♂ No. 53811*	Mass., Wareham, June 9, 1893 ♀ No. 215‡	N. J. May's Landing, Dec. 2, 1892 ♀ No. 567§	N. J. May's Landing, Feb. 16, 1893 ♂ No. 168‖
Basilar length	23.8	23.	23.6	24.	24.4	24.	23.4	24.
Basilar length of Hensel	22.6	21.8	22.	22.6	22.6	22.4	21.8	22.2
Zygomatic breadth	15.2	15.4	16.	16.2	16.6	16.2	16.	16.
Interorbital constriction	3.4	3.4	3.4	3.4	3.6	3.4	3.4	3.4
Greatest length of nasals	7.	6.8	7.	7.	8.	7.4	7.6	7.
Incisor to molar	7.	6.8	6.6	7.	7.	7.	6.6	7.
Incisor to post-palatal notch	12.4	12.	13.	12.8	13.	13.	12.	13.
Foramen magnum to post-palatal notch	9.2	9.	8.8	9.6	9.6	9.2	9.	9.
Upper molar series along crowns	6.4	6.4	6.8	6.6	7.2	6.8	6.8	7.
Basio-occipital to middle of interparietal	7.	7.	6.8	7.2	7.4	7.2	6.8	7.
Fronto-parietal depth at middle of molar series	7.8	7.8	8.	8.	8.8	8.2	8.	8.4
Greatest length of mandible	15.8¶	16.	16.6	16.2	17.	16.4	16.	17.
Lower molar series along crowns	6.	6.	6.4	6.2	6.8	6.4	6.4	6.8

*Skull No. collection of U. S. Department of Agriculture.
†Skull No. collection of Dr. C. Hart Merriam.
‡Collection of E. A. & O. Bangs.
§Collection of S. N. Rhoads [type of S. stonei].
‖Collection of Whitmer Stone [topotype of S. stonei].
¶This measurement is a little too short, as the bone is broken slightly.

From the above measurements, it will be seen that there are no differences of proportion in the skulls of *S. cooperii* and *S. stonei* more than a mere individual variation of the very slightest degree.

I shall now quote from Mr. Rhoads' original description* the specific characters claimed for *S. stonei.*

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*American Naturalist, Vol. 27, pp. 53 and 54, January, 1893.

Mr. Rhoads says:

"*Special characters*, outward appearance and proportions as in *S. Cooperii*. Above blackish-brown, with black hairs more predominant over the shorter brown hairs than in *Cooperii*. The same color reaching around sides of belly instead of being confined to dorsal area as in *Cooperii*. Hoary, gray belly and neck of *Cooperii* replaced by dark plumbeous gray. Feet, including soles, plumbeous, without brown shade. Two middle toes of fore feet, and four inner toes of hind feet, including nails, white. Tail unicolor plumbeous gray. Lips encircled with narrow white edgings."

The color of the type and a topotype of *S. stonei* can be exactly matched by specimens from Massachusetts, Minnesota, Iowa, and North Carolina, of *S. cooperii*.

"Skull narrower," [not so,] "shallower, and viewed from above, less angular than that of *Cooperii*," [not so,] "but of same length. Lower jaws viewed from below, ditto" [exactly like specimens of *Cooperii*]. "Incisors shorter, broader, and less cylindrical, with sulcation of upper pair much more distinct" [characters entirely inconstant]. "Zygomatic foramen longer and narrower" [not so]. "Sagittal suture and parietals relatively much longer; interparietal tranversely narrower, longitudinally longer" [characters not constant]. "Supraoccipital in *cooperii* twice as wide as deep, in *stonei* thrice as wide as deep."

In the type of *stonei*, the only specimen Mr. Rhoads had at the time he described the species, this bone is so broken that its shape cannot be seen. In a topotype of *stonei* I have examined, I can find no difference from *cooperii*.

"Molars one-third wider and one-eighth longer in *stonei*" [width and length vary with age]. "In *cooperii* the length of the symphysis mandibuli just equals the distance from its posterior end to the angle formed by the antero-inferior border of the masseteric fossa; in *stonei* the symphysis is one-third longer" [inconstant].

"Posterior face of angle of lower jaw in *stonei* very stout, abruptly rounded, and recurved outward; in *cooperii* it is slender, spatulate, elongated posteriorly in a nearly vertical plane, and the margin below the condyle not thickened as in the former species."

It is hard to understand just what Mr Rhoads means. I can find no differences whatever between the lower jaws of *S. stonei* and *cooperii.*

Let us now look at the geographical distribution of *Synaptomys cooperii*, and bearing in mind the powerful effect of well defined faunal areas on a species, see what we should expect the *Synaptomys* of south central New Jersey to be.

We have *Synaptomys cooperii* from Minnesota, Iowa, Indiana, Ohio, North Carolina, Maryland and Massachusetts; would it not seem extremely improbable that we should find anything but *cooperii* in New Jersey?

Prof. Baird, in his original description of *Synaptomys cooperii*, says the specimen was "received from Mr. William Cooper of Hoboken. No locality was assigned, but the animal is undoubtedly North American, probably from the New England States or New York; possibly from Iowa or Minnesota." Why not even more probably from New Jersey, as Mr. Cooper lived there?

Since writing this article I have taken two more *Synaptomys cooperii* in Plymouth County, Mass.; one at Plymouth, January 15, 1894 [ad. ♀], and one at Wareham, March 31, 1894 [ad. ♂]. Both were caught in old cranberry bogs, associated with *Arvicola riparius* and using their run-ways.

VOL. IX, PP. 105-108 JUNE 9, 1894

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

A NEW RABBIT FROM WESTERN FLORIDA.

BY GERRIT S. MILLER, JR. AND OUTRAM BANGS.

In a small collection of mammals made in Western Florida during the winter of 1893–1894, by F. L. Small are four specimens of a marsh rabbit that seems to be specifically distinct from *Lepus palustris* Bachman.

Dr. Bachman in his description of *L. palustris** gives no definite type locality, but states that the animal is common in eastern South Carolina and from thence south to southern Florida (on the east side). His description was probably based on South Carolina specimens as it evidently refers to the animal found in that region.

The form from western Florida may be defined as follows:

Lepus paludicola, sp. nov.

Diagnosis.

About the size of *L. palustris* with the hind foot shorter, the ear much shorter, and color generally darker and less yellow, especially about the head and on the under parts. Skull throughout slightly broader and flatter than that of *L. palustris*, the rostral part in particular being disproportionately short and broad.

Description.

Type specimen No. 1451 ♀ ad. Coll. E. A. and O. Bangs, Boston. From Fort Island, near Crystal River, Florida, Jan. 28, 1894. F. L. Small collector. Total length 438 mm ; tail vertebræ 35 mm ; hind foot 84 mm ; (taken in flesh by collector) ; ear 45 mm ; (taken from dried skin).

Color of upper parts russet[*] with black hairs thickly intermixed ; the black hairs predominating on the middle of the back and sides of the head and neck and gradually becoming less conspicuous on the sides, rump and legs. The patch running from between the ears back over the nape is a little brighter than the rest of the upper parts, being a clear bright russet,[*] without inter mixture of black-tipped hairs.

Color of the under parts dirty smoke gray[†] becoming pale cinnamon rufous[§] on the under side of the flanks. Band on the under side of the neck wood brown[‡]. Upper side of feet pale russet[*] with the lower side of the hind feet much darker, almost seal brown[‖] ; ears dark russet[*] bordered on the outer edge by an indistinct line of blackish, and outside this an almost white line running half way up the ear. The feet are very thinly haired and the nails very conspicuous.

Lepus palustris and *L. paludicola* show no differences in color that might not readily intergrade; but the skulls and ears of the two are so different as to lead to the opinion that they are two distinct species, rather than local races of the same species. In all the specimens examined, no sign of inter graduation can be found. Therefore it seems best to accord *L. paludicola* full specific rank for the present, or until intergrades do turn up.

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[*] Journal Acad. Nat. Sciences of Phila., Vol. vii, Pt. II, p. 194, 336.

[*] Nomenclature of Colors, Ridgway, Plate III, No. 16.

[†] Nomenclature of Colors, Ridgway, Pl. II, No. 12.

[§] Nomenclature of Colors, Ridgway, Pl. IV, No. 16.

[‡] Nomenclature of Colors, Ridgway, Pl. III, No. 10.

[‖] Nomenclature of Colors, Ridgway, Pl. III, No. 1.

Measurements of four specimens of *Lepus paludicola*, Miller and Bangs.

Number	1451*	1452*	1453*	1454*
Sex	♀	♂	♂	♀
Locality	Fort Island near Crystal River, Florida.	Salt River near Crystal River, Florida.	Fort Island near Crystal River, Florida.	Fort Island near Crystal River, Florida.
Collector	F. L. Small.	F. L. Small.	F. L. Small.	F. L. Small.
Total length	438	470	428	433
Tail	35	45	33	33
Hind foot	84	85	83	82
Ear from notch	45†	44†	44†	43†
Date	January 28, 1894.	January 27, 1894.	January 28, 1894.	January 29, 1894.

Measurements of four specimens of *Lepus palustris*, Bachman.

Number	745*	744*	1292‡	2173‡
Sex	♂	♂	♀	♀
Locality	Falling Creek, North Carolina.	Falling Creek, North Carolina.	Beaufort County, South Carolina.	Beaufort County, South Carolina.
Collector	O. Bangs.	O. Bangs.	W. Hoxie.	W. Hoxie.
Total length	431	439	....	....
Tail	54.5	58	....	....
Hind foot	99	93.5	85.5†	88†
Ear from notch	62	59.5	56†	54†
Date	January 10, 1894.	December 27, 1893.	September 1, 1885.	December 17, 1885.

*Collection of E. A. and O. Bangs, Boston, Mass. ‡Collection of Dr. C. Hart Merriam.

†Measured from dried skin. All other measurements taken by collector from fresh animal. Measurements in millimeters.

Cranial measurements and ratios of *Lepus paludicola* and *L. palustris.*

	Lepus paludicola.				*Lepus palustris.*			
Number	1452*	1451*	1453*	1454*	744*	745*	1929†	2700†
Sex	♂	♀	♂	♀	♂	♂	♀	♀
Basilar length	66	66	64	65	69	....	66	68
Basilar length of Hensel	60	61	60	60	63.8	....	59.4	61.4
Zygomatic breadth	39	38	37.4	38.8	39	38.6	37	39
Interorbital constriction	18	18	18	18	17		18	18
Greatest length nasals	29.6	30	30	31	34	32.4	32.4	33
Greatest width nasals	15	15	15	16	13	12	13	13
Incisor to molar (alveoli)	20	21.2	21.2	21.2	23		21.6	22
Parieto-basioccipital depth	22	21.4	22	23	24	24	23	22.2
Fronto-palatal depth	19.4	18.2	17.6	18	19	19.8	18.4	19
Length of incisive foramen	17	17	16.2	17	19	18.8	18.4	17.8
Width of incisive foramen	8.8	8.4	7.8	8	7	7	8	6.8
Molar series (alveoli)	15	15	14.8	14.8	15	15	16	14.6
Mandible: length	....	57	54.6	....	59	....	60	55
Mandible: depth through articular process	....	37	35.4	36.4	39.8	....	40	38
Mandible: depth at posterior molar	12	13	12	12.4	14	....	14.4	12.6
Mandible: incisor to molar (alveoli)	15	15.6	15	15.6	16.4	....	15.4	16
Mandibular molar series (alveoli)	15.4	15	15	15.4	15.4	....	17	15.2
Ratios to basilar length—								
of zygomatic breadth	59.09	57.57	58.43	59.69	56.25	....	56.06	57.35
of interorbital constriction	27.27	27.27	28.12	27.68	24.61	....	27.27	26.47
of nasals (length)	44.84	45.45	46.87	47.69	49.27	....	49.09	48.53
of nasals (width)	22.06	22.06	23.43	24.61	18.84	....	19.69	9.11
of parieto-basioccipital depth	33.33	32.42	34.37	35.38	34.78	....	34.87	32.64
Nasals: ratio of width to length	50.67	50.00	50.00	51.57	38.32	36.72	40.12	39.39
Incisive foramen: ratio of width to length	51.76	49.41	48.15	47.06	36.84	37.23	43.36	38.20

*Collection of E. A. and O. Bangs.

†Collection of Dr. C. Hart Merriam.

VOL. IX, PP. 109-116 JUNE 21, 1894

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

PRELIMINARY DESCRIPTIONS OF ELEVEN NEW KANGAROO RATS OF THE GENERA DIPODOMYS AND PERODIPUS.

BY DR. C. HART MERRIAM.

The following brief descriptions are here published in advance of a monographic revision of the group which will appear shortly. Of the eleven new forms here defined, *Dipodomys elator* from northern Texas; *D. ornatus* from the state of Zacatecas, Mexico; *D. m. nitratus* from Owens Lake, California; *Perodipus streatori* from the west slope of the Sierra Nevada, and *P. panamintinus* from the Panamints Mts. in California require no comparison with previously described species. The others are less sharply differentiated.

Dipodomys elator sp. nov.

Type from HENRIETTA, CLAY CO., TEXAS. No. 64,802 ♂ ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected April 13, 1894, by J. Alden Loring (Original number 1,804).

Measurements (taken in flesh).—*Type:* Total length 292; tail vertebræ 173; hind foot 47. Ear from anterior base 14 (in dry skin).

Average measurements of 2 specimens from type locality: Total length 290; tail vertebræ 170; hind foot 45.5.

General characters.—Similar to *Dipodomys spectabilis* but considerably smaller, with much smaller ears; tail more slender and paler, with shorter white pencil; hind feet relatively longer;

facial crescents heavier; nose blacker. Cranial characters unique.

Color.—Upper parts clay-color, lined with dark-tipped hairs on head and back, becoming pale ochraceous buff on flanks; thigh patches large; facial crescents broad and indistinctly continuous to end of nose which is broadly blackish; inner side of legs dusky; dorsal and ventral tail stripes barely meeting in front of white pencil, the white lateral stripes being almost continuous to the white tip; ventral dark stripe pale; dorsal dark stripe pale for proximal ⅔, becoming blackish on crested part; white pencil rather short, measuring about 23 mm. beyond the tips of the black hairs in the two specimens at hand.

Cranial characters.—Skull small for the size of the animal; rather highly arched on top as in *D. phillipsi;* supraoccipital between mastoid bullæ broader than in any other known species; interparietal nearly as broad as long; ascending branches of premaxillæ broad and slightly expanded posteriorly; nasals somewhat narrowed posteriorly; top of skull broad but not broad enough to hide zygomatic arches, which are far apart; sides of frontals sloping strongly inward from point slightly anterior to plane of fronto-parietal suture; nasals decidely longer than frontal breadth immediately behind lachrymals. Mandible small for size of skull; angle large and pointed. Upper premolar an incompletely double prism, its crown with a well developed antero-internal lobe.

Dipodomys ornatus sp. nov.

Type from Berriózabal, Zacatecas, Mexico. No. 57,990 ♀ ad. U. S. Nat. Mus. Department of Agricultural Collection. Collected December 29, 1893 by E. A. Goldman. (Original number 5,613.)

Measurements (taken in flesh).—*Type:* Total length 274; tail vertebræ 167; hind foot 39. Ear from anterior base 15 (in dry skin).

General characters.—Similar to *Dipodomys phillipsi* in size and pattern of markings but brighter and more golden in color; dark markings more extensive and blacker, ears somewhat larger; hind foot shorter; tail crested penicillate, its tip white.

Color.—Upper parts bright golden clay-color, darkest on head and median back, brightest on sides; thigh patches large; facial crescents large, broad, and very black, meeting broadly over bridge of nose which is solid black for ⅓ the distance from nostrils to eye except a small white spot over extreme end of nose; narrow ring round eye, inner sides of hind legs, and dorsal and ventral tail stripes black; tip of tail pure white. The white side stripes of the tail disappear near the junction of the distal and middle thirds, the black stripes uniting in a broad belt anterior to the white pencil. The face is mainly white between the eye and facial crescent, though the white is somewhat obscured, particularly near the eye, by dark-tipped hairs.

Cranial characters.—Skull similar to that of *D. phillipsi* in general size and form, but proportions different. Mandible larger and heavier with much longer and broader angular processes. The basal length and mastoip breadth are essentially the same in the two species, but the naso-occipital length in *ornatus* is much less and the zygomatic breadth very much greater· While the zygomatic breadth is actually greater in *ornatus*, the breadth across the top of the skull is decidedly less: hence when viewed from above, the zygomatic arches stand out beyond the sides of the cranium, while in *phillipsi* they are hidden beneath the edges of the frontals and parietals. In *ornatus* the top of the cranium is much flatter than in *phillipsi*; the supraoccipital is narrower between the mastoid bullæ; the nasals are not narrowed behind, and the ascending branches of the premaxillæ are shorter and more slender and have no trace of the posterior expansion commonly present in *phillipsi*. The upper premolar is a single prism and its crown has no trace of the antero-internal lobe of *phillipsi*.

Dipodomys perotensis sp. nov.

Type from PEROTE, VERA CRUZ, MEXICO. No. 54,285 ♀ ad. U. S. Nat. Mus. Department of Agriculture Collection. Collected May 21, 1893 by E. W. Nelson (Original number 4840).

Measurements (taken in flesh).—*Type:* Total length 265; tail vertebræ 162; hind foot 40. Ear from anterior base 14 (in dry skin).

Average measurements of 8 specimens from type locality: Total length 271; tail vertebræ 168; hind foot 40.4.

General characters.—Similar in size and general appearance to *Dipodomys phillipsi* and *ornatus* and intermediate between them in coloration; white terminal pencil short, and in one specimen absent. Cranial characters substantial.

Color.—Upper parts brownish clay color, intimately mixed with and darkened by blackish-tipped hairs on head and back; strongly suffused with ochraceous buff on sides and flanks; facial crescents large and black, meeting across the nose; inner side of leg and sole blackish; lateral white stripes of tail disappearing near junction of distal and middle thirds; white terminal pencil small and in one specimen absent (possibly the result of injury in early life).

Cranial characters.—Skull similar to that of *D. ornatus*, but even narrower on top [consequently very different from *phillipsi*]; zygoma visible from above; top of skull more strongly arched anteroposteriorly than any other known species; breadth of supraoccipital between inflated mastoids greater than in *phillipsi* or *ornatus*. Angle of mandible larger than in *phillipsi* but smaller than in *ornatus*.

Dipodomys merriami nevadensis subsp. nov.

Type from PYRAMID LAKE, NEVADA. No. 54,552 ♀ ad. U. S. Nat. Mus., Department of Agriculture Collection. Collected June 26, 1893, by Vernon Bailey (Original number 3,990).

Measurements (taken in flesh).—*Type:* Total length 240; tail vertebræ 140; hind foot 39. Ear from anterior base 13 (in dry skin).

Average measurements of five adults from type locality: Total length 243; tail vertebræ 143.5; hind foot 39.9.

General characters.—Similar to *D. merriami* but with shorter tail and longer hind foot; coloration paler and more buffy.

Color.—Upper parts pinkish buff, darkened on head and back by intermixture of dark-tipped hairs; facial crescents distinct but hardly meeting across nose, though bridge of nose is somewhat darkened; face in front of eyes pure white except where interrupted at base of whiskers by facial crescents; underparts and thigh stripes pure white; dorsal and ventral tail stripes dusky, meeting at end of tail; inner side of legs to heel dusky.

Dipodomys merriami nitratus subsp. nov.

Type from KEELER, EAST SIDE OF OWENS LAKE, CALIFORNIA (No. $\frac{25359}{32772}$ ♂ ad. U. S. Nat. Mus. Department of Agriculture Collection). Collected December 29, 1890 by E. W. Nelson (Original number 160).

Measurements (taken in flesh).—*Type:* Total length 237; tail vertebræ 140; hairs 26; hind foot 39. Ear from anterior base 13 (dry skin). Basilar length of skull 22 mm.

Average measurements of 23 specimens from type locality: Total length 239; tail vertebræ 141; hind foot 37.8.

General characters.—Smaller than *D. merriami,* with relatively larger hind feet and wholly different coloration; dusky markings obsolete.

Color.—Upper parts uniform intense ochraceous or tawny-buff not mixed with black-tipped hairs; facial crescents obsolete; no dusky or blackish markings anywhere; no superciliary stripe, but a distinct white spot over eye; upper and lower tail stripes concolor with back; white side stripes continuous.

Dipodomys merriami nitratoides subsp. nov.

Type from TIPTON, SAN JOAQUIN VALLEY, CALIFORNIA. No. 54,674 ♂ ad. U. S. Nat. Mus. Department of Agriculture Collection. Collected June 25, 1893, by Clark P. Streator (Original number 2,978).

Measurements (taken in flesh).—*Type:* Total length 246, tail vertebræ 148; hind foot 36. Ear from anterior base 12 (in dry skin).

Average measurements of 13 specimens from type locality: Total length 237; tail vertebræ 144; hind foot 35.

General characters.—Similar to *D. m. nitratus* in size and color, but with strongly marked facial crescents meeting over bridge of nose; ears smaller.

Calor.—Upper parts everywhere uniform fulvous; facial crescents dusky and meeting over bridge of nose; dorsal tail stripe darker than back; crested part of tail same color as back; ventral tail stripe dull fulvous, continuous to end of tail; inner aspect of hind legs to heel dull fulvous; under parts and thigh stripe white; spot ever eye obscured by dark tipped hairs.

Dipodomys merriami exilis subsp. nov.

Type from Fresno, San Joaquin Valley, California. No. $\frac{34843}{43823}$ ♂ yg. ad. U. S Nat. Mus. Department of Agricultural Collection. Collected September 23, 1891, by Vernon Bailey (Original number 3,277).

Measurements (taken in flesh).—*Type:* Total length 241; tail vertebræ 143; hairs 21; hind foot 33. Ear from anterior base 12 (in dry skin). Bisilar length of skull 21 mm.

Average measurements of 20 specimens from type locality: Total length 227; tail vertebræ 135.5; hind foot 34.

General characters.—Similar to *Dipodomys merriami* but smaller and darker, with upper surface of nose and posterior aspect of ankles black.

Color.—Upper parts nearly uniform clay color, darkened with sepia from abundant admixture of black-tipped hairs, and darkest on the head; sides and flanks tinged with ochraceous-buff; black crescents at base of whiskers sharply defined and meeting in median line so that the bridge of the nose is black: superciliary stripe whitish, not interrupted as in *D. merriami;* ears dark; posterior aspect of ankles and lower leg black; upper and lower tail stripes sooty blackish, meeting along terminal third, thus interrupting the white side stripes; under parts silky white.

Cranial characters.—Skull similar to that of *D. merriami* but much smaller; nasal bones shorter.

Dipodomys merriami atronasus subsp. nov.

Type from Hacienda La Parada, San Luis Potosi, Mexico. No. 50,276 ♂ ad. U. S. Nat. Mus. Department of Agriculture Collection. Collected August 20, 1892, by E. W. Nelson. (Original number 3,229).

Measurements (taken in flesh).—*Type:* Total length 267; tail vertebræ 162; hind foot 40.

Average measurements of 4 specimens from type locality: Total length 250; tail vertebræ 152; hind foot 38.5.

General characters.—Similar to *D. merriami* but darker; pelage coarser, particularly on head.

Color.—Upper parts dark clay-color, everywhere mixed with dark-tipped hairs and suffused with ochraceous buff, which is strongest on the sides; nose from black tip to between eyes grizzled with coarse yellowish, dark-tipped hairs; facial crescents large, black, meeting over end of nose; inner side of thighs and dark tail stripes blackish; white lateral tail stripes mixed with dark hairs and disappearing in middle third of tail.

Perodipus streatori sp. nov.

Type from Carbondale, Mariposa Co., California (at west foot of Sierra Nevada). No. 64,310 ♀ ad. U. S. Nat. Mus. Department of

Agriculture Collection. Collected April 3, 1894, by Clark P. Streator. (Original number 3,673).

Measurements (taken in flesh). *Type:* Total length 292; tail vertebræ 179; hind foot 43. *Average* of 26 specimens from type locality: Total length 295; tail vertebræ 180; hind foot 43.

General characters—Similar to *P. agilis* but larger; ears smaller; tip of tail normally white.

Color.—Upper parts Isabella brown, darker along the middle of the back and on sides of neck; sides and flanks suffused with ochraceous buff; a distinct white spot over eye and at base of ear; top of nose, crescent through base of whiskers, and narrow ring around eye blackish; a band of white overlaid by dark-tipped hairs runs from base of whiskers to ear, including the eye: innerside of thigh and sole of foot blackish; dorsal and ventral tail stripes dusky, meeting in a broad subapical dark ring beyond which the end of the tail is normally *pure white* as in many species of *Dipodomys*; under parts, thigh stripes, and ring at base of tail pure white. Two very young specimens have the white tip of the tail sharply defined but short; some of the old specimens lack the white tip, in others the white side-stripes are nearly continuous to the tip.

Cranial characters.—Skull similar to that of *P. agilis* but larger and heavier; parietals longer antero-posteriorly (inner border decidedly longer than anterior); fronto-parietal suture strongly sinuous, convex forward at median line; supraoccipital broader between mastoid bullæ on top of skull.

Dental characters.—Molariform teeth larger and heavier; crown of last upper molar longer antero-posteriorly and usually more subquadrate; osteodentine islands dark.

Perodipus panamintinus sp. nov.

Type from Panamint Mts., California (on head of Willow Creek). No. $\frac{28566}{40670}$ ♂ ad. U. S. Nat. Mus. Department of Agricultural Collection. Collected May 12, 1891, by E. W. Nelson (Original number 853).

Measurements (taken in flesh).—*Type:* Total length 305; tail vertebræ 183; hind foot 44. Ear from anterior base 15 (in dry skin).

Average measurements of 16 specimens from type locality: Total length 301; tail vertebræ 180.6; hind foot 44.6.

General characters.—Largest species of the genus; coloration ochraceous buffy; does not require comparison with any known species.

Color.—Upper parts pale buffy clay-color, tinged with pale ochraceous; thigh patches large, colored like back; facial crescents and end of nose broadly blackish but barely or not continuous over sides of nose; inner sides of legs dusky; dorsal and ventral tail stripes pale dusky, the ventral stripe failing or indistinctly continuous on distal third, permitting the lateral white stripes to meet below on distal third, nearly as in *P. richardsoni.* Eyelids and anterior part (more than ½) of reflexed upper border of ear blackish; posterior part of ear whitish.

Perodipus ordi columbianus subsp. nov.

Type from Umatilla, Plains of Columbia, Oregon. No. $\substack{24181\\31594}$ ♀ ad. U. S. Nat. Museum. Department of Agriculture Collection. Collected Oct. 18, 1890, by Clark P. Streator (Original number 386).

Measurements (taken in flesh).—*Type:* Total length 254 ; tail vertebræ 148 ; hind foot 40. Ear from anterior base 13 (in dry skin).

Average measurements of 15 specimens from type locality : Total length 244.5 ; tail vertebræ 140.5 ; hind foot 39.

General characters.—Similar to *P. ordi* but less ochraceous in color and with markings more pronounced ; ears blackish instead of flesh color ; supraorbital white spots more conspicuous.

Color.—Upper parts clay-color, finely mixed with dark-tipped hairs ; thigh patches large, more tinged with ochraceous than rest of upper parts, this color reaching down on inner side of leg in a narrow stripe to heel [no dusky on inner side of leg] ; facial crescents blackish and nearly continuous with a blackish spot on end of nose ; supraorbital white spots unusually conspicuous ; interior of ear conch and reflexed upper border blackish ; back side of ear whitish ; dorsal and ventral tail stripes dusky, the ventral failing or nearly failing on terminal fourth, where the white sides stripes commonly meet or nearly meet for a short distance ; tip of tail dusky all round from upper stripe.

Cranial characters.—The skull of *columbianus* differs from that of typical *ordi* in having the basioccipital much broader, the postero-external angle of the maxillary wing of the zygoma more strongly produced backward and downward and the angle of the mandible larger.

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ABSTRACT OF A STUDY OF THE AMERICAN WOOD RATS, WITH DESCRIPTIONS OF FOURTEEN NEW SPECIES AND SUBSPECIES OF THE GENUS NEOTOMA.

BY DR. C. HART MERRIAM.

The following brief abstract of a study of the North American Wood Rats and Desert Rats, with descriptions of a dozen new forms from Mexico and the western United States, based on the rich collections of the United States Department of Agriculture, is here published in advance of a more formal paper on the group. The genus *Neotoma* is here restricted to the species in which the crown of the last lower molar is made up of two transverse loops; the species having the crown of this tooth shaped like the letter S are transferred to the genus *Ptyssophorus* of Ameghino, previously known from a single fossil species from South America. As thus restricted, the genus *Neotoma* is divided into two subgenera, *Neotoma* proper and *Teonoma*, which are complementary in their geographic distribution, *Neotoma* proper being Sonoran or Austral, while *Teonoma* is Boreal. It is convenient to subdivide the former into four minor groups, none of which is worthy of the distinction of subgeneric rank. These groups may be designated, from a typical species in each, as follows: (1) the *leucodon* group; (2) the *mexicana* group; (3) the *desertorum* group, and (4) the *arizonæ* group.

Subgenus NEOTOMA Ord, 1825.

Type, *Neotoma floridana* Ord, from Florida.

Tail commonly round, scant-haired and tapering, but in one species moderately bushy; hind feet small or moderate.

Rostrum of moderate length, never more than one-third the length of cranium; sagittal area usually rounded, the broadest part always considerably anterior to plane of interparietal, whence the sides curve gradually backward to interparietal shield; spheno-palatine vacuities always open.

(1) *Neotoma leucodon group.—Neotoma leucodon, latifrons, micropus, baileyi, floridana* and *pennsylvanica* form a fairly well circumscribed group, differing from the other subdivisions of the genus in having the frontals abruptly spreading and flattened immediately behind the interorbital constriction, the orbital margins upturned and pinched in, almost forming a bead; the nasal bones short and cuneate, tapering evenly to a dull point behind; the postpalatal notch moderately or broadly excavated (moderately in *leucodon,* very broadly in *floridana*); the upper molar series very much broader anteriorly than posteriorly (m ^{1} nearly $\frac{1}{3}$ broader than m ^{3}); m ^{1} comprising three transverse loops, the anterior of which is but slightly indented by the antero-internal sulcus—never divided by the deepening of this sulcus as in the *mexicana* series; color of teeth white or nearly white (except in *floridana,* which is an aberrant member of the group*). *N. pennsylvanica* has certain primitive characters not shared by the others, and is more nearly intermediate between the subgenera *Neotoma* and *Teonoma* than any known living species. The group inhabits the Lower and Upper Sonoran Zones from Perote in Vera Cruz and Berriozabal in Zacatecas, northward to southern South Dakota.

(2) *Neotoma mexicana group.—Neotoma mexicana*†, *pinetorum, orizabæ tenuicauda, fulviventer, fallax and fuscipes* form a group of closely allied species agreeing in certain important cranial characters whereby they differ from all the other subdivisions of the genus. *N. fuscipes*‡ and *fallax* are somewhat aberrant members of the series. *Neotoma torquata* Ward probably belongs here also. The group seems to occupy a midway position in the genus, lacking the more specialized characters that distinguish the others.

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*In most species of *Neotoma* the osteodentine is dark and the reentrant angles are filled with a blackish substance.

†One subspecies of *mexicana* is here recognized: *N. mexicana bullata* from the Santa Catalina Mts. in Arizona.

‡The subspecies of *fuscipes* here recognized are *macrotis* Thomas from the southern coast region of California; *streatori* from the western slope of the Sierra Nevada and adjacent parts of the upper Sacramento Valley, and *dispar* from the east foot of the Sierra along the western edge of the Mohave Desert region. *N. monochroura* Rhoads and *N. splendens* True seem to be typical *fuscipes*, and *N. macrotis simplex* an intergrade.

The upper molar series is of more nearly equal breadth throughout, the anterior molar not being so broad relatively as in the other groups. The postpalatal notch is usually narrow, though it is broadened anteriorly in *N. fuscipes macrotis* of southern California. The frontals increase in width but slightly from before backward, never expanding abruptly behind the interorbital constriction as in the *leucodon* series. The anterior lobe of m ^{1} is completely divided by a deep sulcus on the inner side into two loops, except in *fuscipes*, in which the sulcus is relatively shallower and more anterior in position, the division being less complete than in other species. So far a known the group is restricted to the Upper Sonoran and Transition Zones, where it ranges from southern Mexico (States of Jalisco, Michoacan, Mexico, Puebla, and Vera Cruz) northward in the interior to Colorado and northern Arizona, and along the Pacific Coast to Oregon.

(3) *Neotoma desertorum group.—Neotoma desertorum and intermedia** constitute the third group into which it is convenient to divide the restricted genus. The group is not very sharply defined, some forms of *intermedia* coming very close to aberrant forms of the *leucodon* series. The frontals increase in breadth gradually from before backwards, much as in the *pinetorum* group —not suddenly behind the constriction as in the *leucodon* series. There is no supraorbital bead in typical *desertorum*, but *intermedia* shows a decided tendency to the formation of such a bead. The postpalatal notch is narrower than in any other division of the genus. In dental characters the group resembles the *leucodon* series, the molars being decidedly broader anteriorly than posteriorly, and m ^{1} being made up of three transverse loops, the anterior of which is but faintly indented by the antero-internal sulcus. The members of the group inhabit the Sonoran deserts of northern Mexico and the southern United States, ranging from Chihuahua and Sonora northward to northern Utah, northern Nevada, and middle California.

**Neotoma intermedia* Rhoads inhabits the valleys of the coast reigon of California, south of Monterey Bay. A somewhat paler form, usually more or less suffused with pale ochraceus buffy, inhabits San Gorgonio Pass and the western edge of the Colorado Desert. It was provisionally named *gilva* by Rhoads, and has just been renamed *venusta* by True (in a publication received since the present paper went to press), but seems hardly entitled to the distinction of a separate name. *N. californica* Price seems to be a typical *intermedia*. Two subspecies, *albigula* Hartley from south and west Arizona, and *melanura* nob. from Sonora, are here recognized.

(4) *Neotoma arizonæ group.*—*Neotoma arizonæ and N. lepida*[*] Thomas stand somewhat apart from the other subdivisions of *Neotoma* proper, having bushy tails like those of *Teonoma*, only smaller. In cranial characters they are hardly separable from the *desertorum* group. They inhabit a small area on the southern part of the Colorado Plateau in northern Arizona, northwestern New Mexico, and southeastern Utah, and seem to be restricted to the lower part of the Upper Sonoran Zone.

Respecting the descriptions of new species which comprise the bulk of the present paper, it should be remembered that each relates to a particular pelage. As a rule the summer and winter pelages are different, the winter coat being grayer, the summer coat more ochraceous or fulvous. In some species the summer coat becomes more fulvous or even rusty with age, and the tips of the black hairs wear off, changing the appearance of the animal materially.

Neotoma leucodon sp. nov.

Type from San Luis Potosi, Mexico. No. 50,137 ♂ ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected August 14, 1892, by E. W. Nelson (Original number 3076).

Measurements (taken in flesh).—*Type:* Total length 358; tail vertebræ 164; hind foot 38.5. Ear from anterior base 30 (in dry skin).

Average measurements of 7 males from type locality: Total length 352; tail vertebræ 160; hind foot 39. Average of 3 females from type locality: Total length 342; tail vertebræ 156; hind foot 37.

General characters.—A large species related to *Neotoma micropus* but differing materially in color and in cranial and dental characters.

Color.—Upper parts ochraceous-buff tinged with fulvous and plentifully lined with black hairs; sides relatively free from black hairs; nose and face between eyes grayish; underparts white, with plumbeous underfur on sides of belly; fore and hind feet pure white; tail sharply bicolor, blackish above, white beneath.

Cranial characters.—Skull with the broad frontal platform of *micropus* and *floridana*, but with sides of frontals decidedly upturned and *postpalatal notch narrow*; ascending branches of premaxillæ very long, nearly reaching plane of narrowest part of interorbital constriction; nasals narrow behind and relatively short, barely cutting plane of orbits; jugals short as in *fuscipes*; length of palate from incisive foramina to postpalatal notch nearly or quite equal to length of incisive foramina: audital bullæ large; infraorbital vacuities large; basisphenoid spine about the same breadth as presphenoid.

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[*] The status of *N. lepida* is not very clear. If the type is not a small female of *N. arizonæ*, it must be very closely related.

Dental characters.—Molars large, very broad anteriorly (m^1 nearly $\frac{1}{3}$ broader than m^2), and *white*—the whiteness due in part to the absence of color in the osteodentine, which is dark in other species, and in part to the absence of the usual dark fillings in and about the reentrant angles. M^1 with only 2 salient angles and 1 vertical slit on inner side, the anterior loop being undivided; crown of m^2 a trefoil, the anterior lobe pyriform; m_1 with antero-internal sulcus obsolete, and middle loop more transverse than in *micropus*.

General remarks.—Specimens of this new species have been examined from La Parada, San Luis Potosi, Berrizoabal, Zacatecas and Perote, Vera Cruz. The Perote specimens are somewhat smaller and have the postpalatal notch narrower and the nasals more acutely pointed behind.

Neotoma latifrons sp. nov.

Type from QUERENDARO, MICHOACAN, MEXICO. No. 50,135 ♂ ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected August 8, 1892, by E. W. Nelson (Original number 3058).

Measurements (taken in flesh).—*Type:* Total length 350; tail vertebræ 149; hind foot 42. Ear from anterior base 26 (in dry skin).

General characters.—Similar to *N. leucodon* but smaller, with smaller ears, shorter tail, longer hind feet, and cranial differences.

Color.—Upper parts ochraceous buff tinged with fulvous and moderately lined with dark hairs; the fulvous tinge strongest on sides where it runs forward to cheeks; under parts and feet white, the white of belly and chin clouded with plumbeous from under fur; tail indistinctly bicolor, dusky above, becoming soiled whitish beneath.

Cranial characters.—Skull similar to that of *N. leucodon* but differing in having the frontal platform even broader, its sides strongly spreading immediately behind interorbital constriction, and forming a projecting angle before leaving orbital fossa; skull as a whole shorter and relatively broader; molars narrower and less crowded; m^1 with antero-internal sulcus more pronounced.

Neotoma fulviventer sp. nov.

Type from TOLUCA VALLEY, MEXICO. No. 50,165 ♀ ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected Nov. 5, 1892, by E. W. Nelson (Original number 3744).

Measurements (taken in flesh).—*Type:* Total length 350; tail vertebræ 160; hind foot 34. Ear from anterior base 26 (in dry skin).

General characters.—Similar to *Neotoma tenuicauda* but larger, darker, and under parts dull fulvous instead of white. Ears and feet small; tail slender; texture of pelage fine and soft.

Color.—Upper parts dull fulvous becoming almost dusky along the middle of the back; under parts pale fulvous; fore and hind feet white; tail bicolor, blackish above, soiled whitish below.

Cranial characters.—Skull similar in general to that of *tenuicauda*, but larger; nasals slightly longer (cutting plane of orbits) and rounded instead of truncate behind; jugal very short; anterior spine of basisphenoid longer; distance across molar series posteriorly greater than length of series on crowns [in *tenuicauda* less]; incisive foramina falling considerably short of plane of m [1] [in *tenuicauda* reaching or nearly reaching this plane]. Contrasted with *N. orizabæ* the skull of *fulviventer* is lighter, the nasals truncate anteriorly [instead of projecting acutely], and the molars narrower.

Dental characters.—M [1] with 3 well developed salient angles and two vertical slits on inner side as in *tenuicauda* and *pinetorum*; m [3] also as those species.

Neotoma orizabæ sp. nov.

Type from Mt. Orizaba, Puebla, Mexico. No. 53,653 ♂ ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected April 20, 1893, by E. W. Nelson (Original number 4674).

Measurements (taken in flesh).—*Type:* Total length 356; tail vertebræ 163; hind foot 33. Ear from anterior base 28 (in dry skin).

General characters.—Similar to *Neotoma fulviventer* but upper parts more buffy ochraceous instead of fulvous; belly white instead of dull fulvous; hind feet shorter; pelage coarser; skull and teeth different.

Color.—Upper parts bright ochraceous buff, brightest and purest on the the sides, obscured on the back by black hairs, and becoming grayish on the head; under parts and feet white, the chin and sides of the belly clouded by the plumbeous under fur which shows through; a salmon spot on each side of the breast; tail sharply bicolor, dusky above, whitish below.

Cranial characters.—Skull similar to *N. fulviventer* in general form and tooth characters but heavier; frontal narrower interorbitally with edges more upturned; postpalatal notch broader; nasals projecting much further anteriorly and narrowly rounded off in front [instead of truncate anteriorly]. The ascending branches of the premaxillæ extend only a short distance beyond the nasals.

Dental characters.—The molars are broader and heavier than in *fulviventer* and have larger dentine islands. M [1] has 3 salient angles and 2 vertical slits on the inner side.

General remarks.—Specimens of this general type, differing more or less in minor particulars, have been examined from Chalchicomula, Puebla, Mt. Malinche, Tlaxcala, and Cofre de Perote, Vera Cruz.

Neotoma mexicana bullata subsp. nov.

Type from Santa Catalina Mts., Arizona. No. 16,863 ♂ ad. U. S. Nat.

Museum, Department of Agriculture Collection. Collected June 1, 1889, by Vernon Bailey (Original number 114).

Measurements (taken in flesh).—*Type:* Total length 335; tail vertebræ 151; hind foot 34. Ear from anterior base 22 (in dry skin).

General characters.—Similar to *N. mexicana*; audital bullæ peculiar.

Color.—Upper parts dull ochraceous buff, becoming grayish on the head and legs, and copiously lined with black-tipped hairs on the back; fore and hind feet pure white; under parts white; under fur plumbeous; a faint ochraceous pectoral collar in type specimen; tail bicolor, grayish brown above, whitish beneath.

Cranial characters.—Skull similar to that of *mexicana* in size and general characters; nasal bones broadly truncate posteriorly; audital bullæ rather small and curved toward median line anteriorly in a manner not observed elsewhere in the genus, the inner side decidedly concave, and sloping inward.

Neotoma baileyi sp. nov.

Type from Valentine, Nebraska. No. $\frac{4311}{5034}$ ♀ ad. Merriam Collection. Collected June 16, 1888, by Vernon Bailey (Original number 41).

Measurements (taken in flesh).—*Type:* Total length 371; tail vertebræ 165; hind foot 39. Ear from anterior base 23 (in dry skin).

General characters.—Similar in a general way to *Neotoma floridana*, but ears smaller, tail shorter, color grayer; differs also in cranial characters.

Color.—Upper parts grizzled gray; face nearly clear gray; fore and hind feet white; tail sharply bicolor, dusky above, white below; under parts white to roots of hairs except on sides of belly where the basal fur is plumbeous and shows through.

Cranial characters.—Skull clearly of the *Neotoma floridana-micropus* type, having the frontal platform broad and flat, and the postpalatal notch broadly excavated, but differing from *floridana* in the following characters: Nasal and nasal branches of premaxillæ decidedly shorter; basisphenoid spine narrower and sloping from base to apex where it is continuous with slope of presphenoid; presphenoid without the enlarged base of *floridana*; palate much shorter; incisive foramina decidedly shorter [length of palate from incisive foramina equals length of incisive foramina; in *floridana* the palate is much shorter than incisive foramina]. Molar teeth above and below decidedly larger and heavier than in *floridana*; m ^{1} with antero-internal sulcus nearly obsolete, as in *micropus*.

Neotoma fallax sp. nov.

Type from Gold Hill, Boulder Co., Colorado. No. $\frac{5678}{6345}$ ♂ ad. Merriam Collection. Collected November 1, 1889, by Denis Gale.

Measurements of type (taken from dry skin): Total length 330; tail vertebræ 140; hind foot 31; ear from anterior base 22.

General characters.—Similar to *N. intermedia* in external appearance, but differing in important cranial and dental characters, which place it in the *mexicana-pinetorum* series, of which it is an aberrant member. M_3 with 3 instead of 2 salient angles on outer side—a unique character.

Color.—Upper parts buffy clay color; everywhere finely lined with black hairs; under parts white, the under color plumbeous and showing through except in a narrow strip along the median line where the hairs are white to roots; fore and hind feet pure white; tail bicolor, dusky above, white below.

Cranial characters.—Skull similar to that of *mexicana* but differing from *mexicana* in the following particulars: Nasals narrower posteriorly and reaching posterior plane of lachrymals; ascending branches of premaxillæ exceeding nasals but little; audital bullæ less globular; frontals much broader posteriorly.

Dental characters.—Molars as in *mexicana*; m^1 with a strongly developed antero-internal lobe (having 3 instead of 2 salient angles on inner side); m_3 with antero-external loop (having 3 salient angles instead of 2 on outer side, and 2 reentrant angles instead of 1.)

Neotoma fuscipes streatori subsp. nov.

Type from CARBONDALE, AMADOR CO., CALIFORNIA. No. 64,439 ♂ ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected April 4, 1894, by Clark P. Streator (Original number 3685).

Measurements (taken in flesh).—*Type:* Total length 382; tail vertebræ 175; hind foot 38. Ear from anterior base 25 (in dry skin).

Average measurements of 3 adult specimens from type locality: Total length 380; tail vertebræ 183; hind foot 37.

General characters.—Similar to *N. fuscipes* in size and color, but ears broader; ankles somewhat darker; hind feet from ankles pure white. Cranial characters pronounced.

Color.—Upper parts dark grizzly brown, strongly suffused with fulvous, which is brightest and palest on the sides. Under parts creamy white. Tail bicolor, blackish above, whitish below, with distinct line of demarkation; black upper surface covering slightly more than half of circumference of tail. Ankles dusky, in sharp contrast with pure white of feet, and darker than legs; dusky ankle patch covering both sides of but not reaching metatarsus, leaving outer side of heel white.

Cranial characters.—Skull similar to that of *N. fuscipes dispar*; palate short, barely equalling length of interpterygoid fossa and of basisphenoid [much longer in *fuscipes*]; incisive foramina reaching back past plane of first molars [not reaching this plane in *fuscipes*]; pterygoid fossa narrow and rounded anteriorly as in *dispar*.

Neotoma fuscipes dispar subsp. nov.

Type from LONE PINE, OWENS VALLEY, CALIFORNIA. No. $\frac{25391}{32804}$ ♂ ad. U.

S. Nat. Museum, Department of Agriculture Collection. Collected December 25, 1890 (Original number 2310).

Measurements (taken in flesh).—*Type:* Total length 410; tail vertebræ 208; hind foot 39. Ear from anterior base 31 (in dry skin).

General characters.—Similar to *Neotoma fuscipes* in size and proportions except that the tail is not so long; coloration pale, much as in the Mohave Desert *N. mexicana desertorum*; tail strongly bicolor.

Color.—Entire upper parts ochraceous buff, palest on the head; back moderately lined with black-tipped hairs; feet and under parts white; the white of the belly enroached upon by the buffy-ochraceous of the sides; tail bicolor; above brownish-gray; below soiled white, with distinct line of demarkation. The grayish-brown of the ankles is pale and does not extend out over the metatarsals.

Cranial characters.—The skull is clearly of the *fuscipes* type, having the long rostrum, long nasal bones, and last upper molar of that species. It differs from typical *fuscipes* (from north of Monterey Bay) in the following particulars: Zygomatic arches narrow and much less spreading anteriorly; nasal branches of premaxillaries shorter; palate shorter; interpterygoid fossa longer; postpalatal notch somewhat broader and evenly rounded anteriorly; angular processes of mandible much sharper (not rounded off as in *fuscipes*). The best characters are the shortness of the palate, the depth of the pterygoid fossa, and the broadly rounded form of the postpalatal notch. In typical *fuscipes* this notch is narrow, abruptly truncated anteriorly, and usually enroached upon by a blunt projection from the posterior edge of the palate. In subspecies *macrotis* the pterygoid fossa is much broader and shorter.

Neotoma desertorum sp nov.

Type from FURNACE CREEK, DEATH VALLEY, CALIFORNIA. No $\frac{25739}{33139}$ ♂ ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected January 31, 1891, by T. S. Palmer (Original number 43).

Measurements (taken in flesh).—*Type:* Total length 305; tail vertebræ 128; hind foot 30. Ear from anterior base 27 (in dry skin).

Average measurements of eight males from type locality: Total length 299; tail vertebræ 132.5; hind foot 30. Average of thirteen females from type locality: Total length 284; tail vertebræ 128; hind foot 29.

General characters.—Similar to *N. intermedia* in general appearance but decidedly smaller, with larger ears, softer and more silky pelage, coloration more ochraceous buffy instead of gray. Skull characters distinctive.

Color.—Upper parts pinkish buff, most intense on the sides, becoming grayish on the head, finely lined on the back with blackish hairs; fore and hind feet pure white; tail bicolor, pale dusky above, white beneath; under parts superficially white, more or less washed with salmon on the neck, breast and belly (often forming a roseate pectoral collar); hairs plumbeous at base except a pectoral patch and an irregular strip down the middle of the belly, which are white throughout. Some specimens from old Fort Yuma have the upper parts very pale buffy.

Cranial characters.—Skull much smaller, thinner, and less angular than that of *intermedia* or *albigula*; interparietal much smaller and less elongated transversely; interorbital constriction much narrower, with edges more upturned; audital bullæ much larger; opening of posterior nares narrower; nasals truncate but less broadly than in *intermedia.*

Neotoma desertorum sola subsp. nov.

Type from San Emigdio, Kern Co., California. No. $\frac{31516}{43381}$ ♂ ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected October 24, 1891, by E. W. Nelson (Original number 1369).

Measurements (taken in flesh).—*Type* (male): Total length 330; tail vertebræ 148; hind foot 36. Ear from anterior base 29 (in dry skin). Female from type locality: Total length 324; tail vertebræ 151; hind foot 33.5.

General characters.—Similar to *N. desertorum,* but larger.

Color.—Upper parts ochraceous buff, lined with black-tipped hairs; fore and hind feet and underparts white; basal fur plumbeous on sides of belly and chin; tail bicolor, grayish brown above, white below.

Cranial characters.—Skull similar to that of *desertorum* but larger; interorbital breadth greater; interparietal much larger; audital bullæ less inflated; nasals longer, and broader posteriorly; ascending branches of premaxillæ shorter and slighter.

Neotoma intermedia melanura subsp. nov.

Type from Ortiz, Sonora, Mexico. No. $\frac{17819}{24756}$ ♂ yg. ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected November 13, 1889, by Vernon Bailey (Original number 671).

Measurements (taken in flesh).—*Type:* Total length 333; tail vertebræ 170; hind foot 34. Ear from anterior base 25 (in dry skin).

General characters.—Size rather small; ears large; coloration peculiar; back olivaceus; *tail black above* (probably a peculiarity of winter pelage); cranial characters of the *albigula* type.

Color.—(Winter pelage) Upper parts olivaceus from a fine intermixture of black-tipped hairs on an ochraceus-buffy ground; sides nearly clear ochraceus-buff; fore and hind feet pure white; ankles blackish in sharp contrast to color of hind feet; tail sharply bicolor, dorsal side *black,* ventral side white; under parts white; chin, throat, breast and line down middle of belly white to roots of hairs; sides of belly with plumbeus under fur.

Cranial characters.—Skull similar to that of *N. intermedia* but smaller; nasals narrower posteriorly: anterior loop of m^1 partly divided by antero-internal sulcus.

Geneal remarks.—This animal in winter pelage looks like immature specimens of *N pinetorum,* but the marked cranial characters serve to distinguish it at once. No specimens in summer pelage are at hand from the type locality, but specimens from Hermosillo and Magdalena, apparenty the same sub-species, are grayer, the black hairs of the back are inconspicuous, and the upper side of the tail is less black.

Neotoma intermedia angusticeps subsp. nov.

Type from S. W. Corner of Grant Co., New Mexico (only 5 miles from Mexican boundary). No. $\frac{2325}{2833}$ ♂ ad. Merriam Collection. Collected April 12, 1886, by A. W. Anthony (Original number 62).

Measurements of type specimen: Total length 335 (measured in flesh). Tail vertebræ 150; hind foot 33; ear from anterior base 25 (in dry skin).

General characters.—Similar to *N. albigula,* but ears smaller; color more strongly fulvous; skull more elongated and narrower.

Color.—(Summer pelage) Upper parts fulvous, becoming ochraceous buff on the head, and abundantly lined with black hairs; feet and under parts creamy white to roots of hair, except on sides of belly where the basal hair is plumbeous; tail bicolor, grayish brown above, white beneath.

Cranial characters.—Skull similar to that of *albigula* but longer and more slender: Basal length 42; basilar length of Hensel 39.5; greatest zygomatic breadth 24; interorbital constriction 6. Cranium rather smoothly rounded —not so angular as in *intermedia* and *albigula;* zygomatic arches narrow and less angular posteriorly than usual in the group; frontals broad interorbitally but not widening rapidly behind constriction, the orbital margins neither beaded nor upturned; nasals cuneate; ascending branches of premaxillæ normally thickened behind nasals but not divaricating; interparietal shield subquadrate; anterior loop of m ^{1} only slightly indented by sulcus.

Subgenus TEONOMA Gray, 1843.

Type, *Neotoma cinerea drummondi* (Richardson) from the Rocky Mts. 57° N.

Tail very large, bushy, and somewhat distichous, like a squirrel's; hind feet very large.

Rostrum much elongated, measuring more than one-third the total length of cranium; posterior roots of zygomata widely spreading; sagittal area long, narrow, and sharply angular, its broadest part far back, on or nearly on plane of anterior border of interparietal, whence the sides bend abruptly back to interparietal shields; spheno-palatine vacuties closed or open.*

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*In a previous communication (Proc. Biol. Soc. Wash. viii, July, 1893, 112), I called attention to the circumstance that the long vacuities always present on each side of the presphenoid and anterior part of the basisphenoid in *Neotoma* proper, are closed by ascending wings from the palatine bones in *N. cinerea* and *occidentalis*. I then regarded this character as of sub-generic weight. It now appears to be of specific weight only, for the vacuities are open in the new species from Colorado here described as *N. orolestes*.

The members of this series are a very compact group, comprising *N. cinerea* with its subspecies *drummondi* and *occidentalis*, and *N. orolestes* nob.

Neotoma orolestes sp. nov.

Type from SAGAUCHE VALLEY (20 miles west of Sagauche) COLORADO. No. $\frac{35906}{48215}$ ♂ ad. U. S. Nat. Museum, Department of Agriculture Collection. Collected August 13, 1892, by J. Alden Loring. (Original number 482).

Measurements (taken in flesh).—*Type:* Total length 413; tail vertebræ 175; hind foot 41. Ear from anterior base 31 (dry skin).

General characters.—Similar to *N. cinerea;* size large; tail large and bushy; sphenopalatine vacuities open.

Color.—Upper parts in summer pelage buffy-ochraceous, more or less suffused with fulvous and everywhere lined with black hairs; top of head grayish, becoming clear gray on nose; cheeks buffy-ochraceous; under parts and feet white; color of hind legs reaching out a short distance over tarsus; sides of belly with plumbeous underfur; tail bicolor; dorsal side concolor with back on proximal $\frac{1}{3}$, becoming dusky on distal $\frac{2}{3}$; ventral side whitish, obscured by pale fulvous proximally.

Cranial characters.—Skull similar to that of *N. cinerea* but differing in having the sphenopalatine vacuities open, the ascending wings of the palatines leaving a long open slit on each side of the presphenoid and anterior third of the basisphenoid. The mandible differs in having the angle larger, longer, and more everted, the extreme tip falling outside of the vertical plane of the condyle.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

DESCRIPTION OF A NEW FIELD MOUSE (*ARVICOLA TERRÆNOVÆ sp. nov.*) FROM CODROY, NEWFOUNDLAND.

BY OUTRAM BANGS.

Since November, 1893, Mr. Ernest Doane has been collecting mammals for me in Newfoundland. He has so far sent, among other things, a series of over sixty beautifully prepared skins and skulls of an *Arvicola* that seems to be entirely different from any known species.

This *Arvicola* may be defined as follows:

Arvicola terrænovæ sp. nov.

Diagnosis.

About the size of *Arvicola riparius* Ord, but with larger feet, and of a slightly different coloring, especially about the under parts, which are so much lighter and never show the rufous tinge so common in *riparius*, with nose-patches similar to those of *A. xanthognathus* Leach and *A. chrotorrhiaus* Miller, though not so pronounced as in either of those two. Skull rather broader than that of *A. riparius* and the zygoma more flaring, suggesting the general appearance of the skull of *A. xanthognathus*. The enamel pattern more like that of *riparius*, but the posterior loop of the last upper molar trifoliate.

Description.

Type.—No. 1104 ♂ ad. Coll. of E. A. and O. Bangs, Boston, Mass. From Codroy, Newfoundland, Nov. 27, 1893, Ernest Doane, collector. Total length, 187 mm.; tail, 54 mm.; hind foot, 24 mm.; ear, 12 mm. (These measurements taken in flesh by the collector.)

Above: Brown, of a color between raw umber and Prout's brown, becoming gradually lighter on the sides, with a slight sprinkling of shining black-tipped hairs on the back.

Under parts: Grey No. 9,* with an indistinct line of darker (about the color of the sides) running up the middle of the belly nearly to the front legs.

There is a well defined nose-patch extending from the nose to and around the roots of the whiskers, of a dull tawny color. The base of the hair is everywhere blackish slate. The tail is distinctly bicolored—above, black; below, grey No. 10,* and quite hairy.

Cranial and dental characters: The skull of *Arvicola terrænovæ* is broad and short, and has the flaring zygoma and great interorbital constriction of *A. xanthognathus.* The rostral part is also narrow as in that species. The pattern of enamel folding is, on the other hand, more like that of *A. riparius*, with the difference that the last loop of the posterior upper molar is trifoliate, as against the cresent shape of *riparius* There are one or two other trifling differences in the enamel folding that can be better seen by a critical examination of the accompanying drawing.†

This Arvicola seems to occupy an intermediate position between the *xanthognathus* and *riparius* groups. The indication of nose-patches can occasionally be found in individuals of *A. riparius,* but I never have seen a series from any one place that shows any tendency to this marking, while every one of my series of sixty-three *A. terrænovæ* has a distinct, though dark colored and not conspicuous nose-patch.

The rather peculiar marking of the under parts is constant through the entire series; indeed, I have seldom seen a series of mammals more uniform in every respect.

Mr. Doane found this field mouse common everwhere about Codroy, where he spent the winter, and where all my specimens came from.

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*Ridgway's Nomenclature of colors, Plate II.

†Excellent figures of the skulls of *A. riparius*, *A. xanthognathus*, and *A. chrotorrhinus* can be found in "On a Collection of Small Mammals from the New Hampshire Mountains, by Gerrit S. Miller, Jr.", in the Proceedings of the Boston Society of Natural History, Vol. XXXVI, Plate 3.

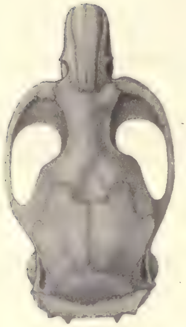

Fig. 1.

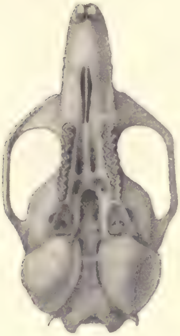

Fig. 2.

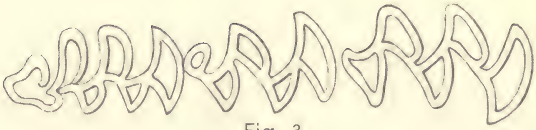

Fig. 3.

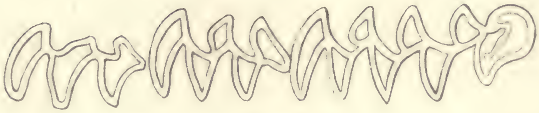

Fig. 4.

A. M. Westergren, del. Forbes Lith. Mfg. Co.

Figs. 1 and 2. Skull of the Type *Arvicola terræ novæ*–*Bangs*. About × $\frac{2}{3}$

Fig. 3. Maxillary Molar Series. About × $10\frac{1}{2}$

Fig. 4. Mandibular Molar Series. About × $10\frac{1}{2}$

Measurements of ten adult specimens of *Arvicola terrænovæ* Bangs.

No.	Locality.	Date.	Sex.	Total length.	Tail vertebræ	Hind foot.	Height of ear.
Type *1104	Codroy, Newfoundland	Nov. 27, 1893	♂	187	54	24	12
Topo-type 1133	“ “	Nov. 23, 1893	♂	175	47	25	12.5
“ 1120	“ “	Dec. 11, 1893	♂	160	47	23	13
“ 1134	“ “	Apr. 15, 1894	♂	176	45	24	13
“ 1135	“ “	Apr. 17, 1894	♂	178	50	24	13
“ 1136	“ “	Apr. 16, 1894	♀	156	45	23	13
“ 1137	“ “	Apr. 10, 1894	♀	158	46	25	13
“ 1138	“ “	Apr. 16, 1894	♀	170	55	22	12
“ 1139	“ “	Apr. 10, 1894	♀	172	48	23	13
“ 1140	“ “	Apr. 10, 1894	♀	170	48	24	12

*Collection of E. A. and O. Bangs, Boston, Mass.

Cranial measurements of ten adult specimens of *Arvicola terrænovæ* Bangs.

	Type	Topo-type	Topo-type	Topo-type	Topo-type	Topo-type	Topo-type	Topo-type	Topo-type	Topo-type
No. *	1104	1109	1106	1105	1135	1137	1139	1140	1143	1145
Sex	♂	♂	♂	♂	♂	♂	♀	♀	♀	♀
Basilar length	27.	26.	26.2	25.8	28.	25.4	26.8	27.	25.2	26.4
Basilar length of Hensel	25.4	24 2	25.	24.2	26.4	24.	25.	25.8	24.	24.8
Zygomatic breadth	16.2	15.8	15.4	15.6	16.8	15.2	16.	16.	15.2	16.
Interorbital constriction	3.8	4.	4.	3.8	4.2	4.	4.	4.	3.8	4.
Greatest length of nasals	8.4	7.8	7.2	7.8	8.	7.2	7.6	8.	7.	7.4
Greatest breadth of nasals	3.2	3.2	3.2	3.	3.4	3.	3.4	3.4	2.8	3.4
Incisor to molar	8.4	8.2	8.4	8.2	9.2	8.	9.	9.	8.	8.2
Incisor to post-palatal notch	14.4	13.8	14.6	14.	15.4	14.	14.4	15.	13.4	14.2
Foramen magnum to post-palatal notch	10.8	10.2	10.	10.	10.8	10.	10.4	10.4	10.	10.2
Upper molar series along crowns	6.8	6.6	6.6	6.4	7.	6.6	6.6	6.8	6.4	6.6
Basioccipital to middle of parietal	8.6	8.4	8.2	8.4	9.2	8 6	8.4	8.6	8.2	8.4
Fronto-parietal depth at middle of molar series	9.	8.8	8.6	8.6	9.2	8.4	8.8	8.8	8.2	9.
Greatest length of mandible	17.	16.8	17.	16.6	17.8	16.4	17.4	17.6	16.2	17.4
Length of lower molar series along crowns	7.	6.6	6.8	6.4	7.	6.4	6.8	7.	6.4	7.

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*Collection of E. A. and O. Bangs, Boston, Mass.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

DESCRIPTION OF A NEW MUSK RAT FROM CODROY, NEWFOUNDLAND.

BY OUTRAM BANGS.

A fine series of musk rats lately received from Codroy, Newfoundland, shows such differences from *Fiber zibethicus* (Linn.) of Eastern North America that I think it must be regarded as representing a distinct species.

This *Fiber* may be defined as follows:

Fiber obscurus sp. nov.

Diagnosis.

Smaller than *F. zibethicus* (Linn.), with the under parts and sides less ferruginous and the upper parts much darker. The lips and the hairs about the under side of the nose are much lighter (pure white). The fringe of long hair around the toes of the hind feet is decidedly lighter than the feet, while in *F. zibethicus* this fringe is generally of about the same shade as the feet. The under fur is darker than in *zibethicus*. Skull smaller and smoother, not rising into such pronounced bong ridges with age, with the rostrum relatively larger and the audital bullæ relatively smaller, while the interorbital constriction is actually broader.

Description.

Type.—No. 1155 Collection of E. A. and O. Bangs, Boston, Mass. From Codroy, Newfoundland, May 14, 1894, Ernest Doane, collector. Total length, 476 mm.; tail, 200 mm., hind foot, 70 mm.; ear from notch, 22 mm. (Measurements taken in flesh by the collector).

Upper parts: General color Prout's brown,* shaded a little with Vandyke brown,* darkening on the top of the head to almost black. The long shining hairs are black all over the back, but on the sides they shade off a little to a very dark reddish brown.

Under parts and sides of the head of a shade between Prout's brown,* and broccoli brown,* paling off on the under side of the neck and legs to almost fawn color.* Lips and hair under the nose white. Under fur slate grey everywhere. Feet blackish slate,* with the fringe of long hair around the toes of the hind feet Isabella color.*

Cranial characters: Skull small and smooth, and broad between the orbits, with large rostrum and small audital bullæ.

Specimens taken later in the season than the type are rather more reddish (ferruginous) in general color, but compared with specimens of *F. zibethicus* of corresponding dates from Massachusetts, Nova Scotia, etc., the difference is quite as great as between the type and examples of *F. zibethicus* of the same date as the type from those localities.

I have carefully compared musk rats from our Eastern Coast from Connecticut to Cape Breton and can find no difference in specimens of the same age and season and no tendency towards a small dark northern race,† and therefore incline to the belief that *F. obscurus* is an insular form peculiar to Newfoundland. I have however never seen any musk rats from Labrador, and it is possible that there the animal may be more like the one found in Newfoundland.

---

*Ridgway's Nomenclature of colors.

†The largest musk rat I have examined is from Shenacadie (Cape Breton) Nova Scotia. It is a very old adult male. No. 2007, Collection of E. A. and O. Bangs, and measures, total length, 632 mm.; tail, 291 mm.; hind foot, 87 mm.; ear from notch, 26.5 mm.

Cranial measurements of ten adult specimens of *Fiber zibethicus* (Linn.).

Locality	Mass., Wareham.	Mass., Wareham.	Mass., Wareham.	Mass., Wareham.	Nova Scotia, Shenacadie.	Nova Scotia, Halifax.	Nova Scotia, Shenacadie.	Nova Scotia, Shenacadie.	Nova Scotia, Shenacadie.	Nova Scotia, Shenacadie.	Average measurements of the ten specimens.
No. *	922	924	923	925	2009	2004	2007	2008	2010	2011	
Sex	♀	♀	♂	♂	♂	♀	♂	♂	♀	♀	
Basilar length	62.4	62.4	62.	61.2	61.2	59.8	63.4	67.	65.8	61.8	62.7
Basilar length of Hensel	58.8	59.4	58.6	58.	58.2	57.4	60.6	64.4	62.6	59.	59.7
Zygomatic breadth	41.2	42.2	40.	39.8	39.8	38.4	39.8	44.2	42.2	39.6	40.72
Interorbital constriction	5.4	6.	6.	5.6	6.2	6.	6.6	5.	6.6	6.2	5.96
Greatest length of nasals	22.6	22.6	23.4	22.4	22.6	21.2	23.6	25.4	24.8	22.6	23.12
Greatest breadth of nasals	9.4	9.2	9.2	8.8	9.6	8.6	9.4	9.8	10.2	9.	9.32
Incisor to molar	23.2	23.6	22.6	22.4	23.	22.2	23.6	26.6	25.4	22.8	23.54
Incisor to post-palatal notch	36.6	37.6	36.6	36.4	35.8	36.4	36.6	40.	40.6	37.	37.36
Foramen magnum to post-palatal notch	21.8	21.4	21.6	21.2	22.	20.6	23.6	24.	21.6	21.6	21.94
Upper molar series along crowns	14.6	15.2	15.2	14.6	14.8	14.4	15.	14.8	14.8	15.	14.84
Basioccipital to middle of parietal	19.	18.8	18.4	18.4	17.4	17.4	17.4	19.	19.	17.8	18.26
Fronto-parietal depth at middle of molar series	21.2	20.4	20.6	20.	19.8	19.8	20.	22.6	21.6	20.2	20.62
Greatest length of mandible	44.6	44.4	43.2	43.	43.2	42.2	42.4	47.	46.	43.4	43.94
Length of lower molar series along crowns	15.6	16.4	16.	15.4	16.	15.4	15.2	16.4	15.4	16.	15.78

*Collection of E. A. and O. Bangs, Boston, Mass.

Cranial measurements of ten adult specimens of *Fiber obscurus* Bangs.

No. . . . . *	Type 1155	1101	1156	1158	1162	1161	1151	1152	1153	1157	Average meas-urem'ts of the 10 specimens.
Sex	♀	♀	♀	♀	♀	♀	♂	♂	♂	♂	
Basilar length	54.6	56.8	51.4	54.8	57.2	52.4	58.	54.4	53.4	54.2	54.72
Basilar length of Hensel	52.	54.	48.8	52.	54.8	50.	55.4	52.4	50.4	51.2	52.10
Zygomatic breadth	36.6	38	34.	35.2	38.2	35.8	39.	36.2	36.	35.4	36.44
Interorbital constriction	6.6	7.2	6.4	6.8	7.	7.	7.	6.4	6.4	6.4	6.72
Greatest length of nasals	22.2	22.	19.4	20.8	20.8	20.2	22.4	20.	19.6	20.	20.74
Greatest breadth of nasals	8.	8.	7.6	7.6	8.8	8.	8.8	7.4	8.	8.	8.02
Incisor to molar	21.	21.8	19.4	20.6	22.	21.	22.	20.6	20.2	20.2	20.88
Incisor to post-palatal notch	33.2	34.	30.4	32.8	34.4	31.	34.4	32.8	31.6	32.6	32.72
Foramen magnum to post-palatal notch	18.4	19.6	18.	18.4	20.	18.8	20.6	19.	19.	18.	18.98
Upper molar series along crowns	13.	13.2	12.6	13.	13.2	12.	13.8	12.4	13.	13.	12.92
Basioccipital to middle of parietal	17.	17.4	16.6	16.8	17.4	16.4	18.	17.	17.	17.	17.06
Fronto-parietal depth at middle of molar series .	18.	18.8	16.4	17.4	18.8	17.	19.2	18.	17.2	17.4	17.82
Greatest length of mandible	38.4	40.2	36.	38.	40.	37.	40.4	37.8	37.6	37.4	38.28
Length of lower molar series along crowns . . .	13.4	14.	13.4	13.4	13.4	12.	14.2	13.	13.4	13.	13 32

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*Collection of E. A. and O. Bangs, Boston, Mass.

Measurements of ten adult specimens of *Fiber zibethicus* (Linn.)

No.	Sex.	Locality.	Date.	Total length.	Tail vertebræ.	Hind foot.	Height of ear from notch.
*922	♀	Massachusetts, Wareham	July 26, 1893	622	259	84	23.5
924	♀	“ “	Aug. 4, 1893	619	284	84.5	28
923	♂	“ “	Aug. 7, 1893	622	281	80	26
925	♂	“ “	May 6, 1893	582	257	84	23
927	♂	Massachusetts, West Tisbury	June 28, 1893	620	267	79	20.5
2004	♀	Nova Scotia, Halifax	July 17, 1894	540	225	77	25
2007	♂	Nova Scotia, (Cape Breton) Shenacadie	July 26, 1894	632	291	87	26.5
2008	♂	“ “ “ “ “	July 30, 1894	598.5	278	81	23.5
2010	♀	“ “ “ “ “	July 29, 1894	622	287	85	25
2011	♀	“ “ “ “ “	July 25, 1894	558.5	247	80	23
Average measurements of the ten specimens, ...				601.6	267.6	82.15	24.40

---

*Collection of E. A. and O. Bangs, Boston, Mass.

Measurements of ten adult specimens of *Fiber obscurus* Bangs.

No.	Sex.	Locality.	Date.	Total length.	Tail vertebræ	Hind foot.	Height of ear from notch.
Type *1155	♀	Codroy, Newfoundland	May 14, 1894	476	200	70	22
" 1101	♀	" "	Dec. 6, 1893	517	228	74	18
" 1156	♀	" "	May 20, 1894	440	173	70	19
" 1158	♀	" "	May 8, 1894	474	220	71	19
" 1160	♀	" "	May 7, 1894	517	220	70	20
" 1162	♀	" "	July 9, 1894	504	217	72	21
" 1151	♂	" "	May 15, 1894	520	223	69	20
" 1152	♂	" "	May 14, 1894	480	217	69	20
" 1153	♂	" "	May 7, 1894	447	190	70	19
" 1154	♂	" "	May 15, 1894	495	220	74	22
Average measurements of the ten specimens, ...				487	210.8	70.9	20.

*Collection of E. A. and O. Bangs, Boston, Mass.

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BIOLOGICAL SOCIETY OF WASHINGTON

FOR 1896

(ELECTED DECEMBER 27, 1895)

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* Ex-Presidents of the Society.

† Deceased.

VOL. X, PP. VII-XII DECEMBER 31, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

PROCEEDINGS.

The Society meets in the Assembly Hall of the Cosmos Club on alternate Saturdays at 8 p. m. Brief notices of the meetings are published in '*Science*.'

January 11, 1896—253d Meeting.

Vice-President B. E. Fernow in the chair and one hundred and thirteen persons present.

The following communications were presented:

Gerrit S. Miller, Jr.: The Subgenera of Voles (*Microtinæ*).*

T. S. Palmer: Rabbit Drives in the West.† (Illustrated by lantern slides.)

V. A. Moore: The Flagella of Motile Bacteria with special Reference to their Value in Differentiating Species.‡ (Illustrated by lantern slides.)

January 25, 1896—254th Meeting.

Vice-President B. E. Fernow in the chair and twenty-three persons present.

The following communications were presented:

Charles F. Simpson: On the Extra-limital Mississippi Unios.§

M. B. Waite: The Life History of the Pear Blight Microbe.||

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* Genera and Subgenera of Voles and Lemmings. <N. Am. Fauna, No. 12, pp. 78, pls. iii, text figs. 40, July 23, 1896.

† The Jack Rabbits of the United States. <Bull. No. 8, Div. Ornithology and Mammalogy, U. S. Dept. Agriculture, chap. V, pp. 47–64, March, 1896.

‡ Journ. Am. Public Health Asso., xx, 432–444, October, 1895.

§ Am. Nat., 30, 379–384, May, 1896.

|| Bull. No. —, Div. Vegetable Phys. and Path., U. S. Dept. Agric. (In press.)

Pierre A. Fish: The Action of Electricity upon Nerve Cells.*

Vernon Bailey: Tamarack Swamps as Boreal Islands.†

February 8, 1896—255th Meeting.

The President in the chair and thirty-two persons present.

The following communications were presented:

David White: Some new Forms of Palæozoic Algæ from the Central Appalachian Region.

Charles L. Pollard: Observations on the Flora of the District of Columbia.‡

On the call for short notes—

F. V. Coville exhibited *Anhalonium lewinii*, a poisonous cactus from Texas; and

C. L. Pollard discussed *Asclepias albicans* as a desert plant.

February 22, 1896—256th Meeting.

The President in the chair and thirty persons present.

The following communications were presented:

C. Hart Merriam: The American Weasels.§

F. E. L. Beal: The Food of the Bluejay.||

David White: On the Structure and Relations of *Buthograptus*, *Plumulina*, and *Ptilophyton* from the North American Palæozoic.

Sylvester D. Judd: A Peculiar Eye of an Amphipod Crustacean.

Vernon Bailey: Two Mammals new to the Vicinity of Washington [*Synaptomys cooperi* and *Sorex personatus*].

March 7, 1896—257th Meeting.

The President in the chair and thirty-three persons present.

The following communications were presented:

Adrian J. Pieters: The Influence of Fruit-bearing on the Mechanical Tissue of the Twigs.¶

Edward L. Greene: The Distribution of *Rhamnus* and *Ceanothus* in America.**

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* Proc. Am. Microscopical Soc., xvii, 179–185, 1895.

† Science, NS., iii, p. 250, February 14, 1896.

‡ Published in part in Bot. Gaz., 21, 233–235, 1896.

§ Synopsis of the Weasels of North America. <N. Am. Fauna, No. 11, pp. 35, pls. v, text figs. 16, June 30, 1896.

|| Yearbook U. S. Dept. Agriculture, 1896. (In press.)

¶ Annals of Botany. (In press.)

** Published in part in Erythea, iv, pp. 83–86, 1896.

F. V. Coville: Different Editions of Some Government Expedition Reports.*

March 21, 1896—258th Meeting.

The President in the chair and forty-seven persons present.

The following communications were presented:

B. W. Evermann: Animals from an Artesian Well at San Marcos, Texas.

In the discussion Dr. Leonhard Stejneger described a remarkable blind salamander occurring in the same well.

C. Hart Merriam: The Big Bears of North America.†

Henry H. Dixon: Recent Researches on the Ascent of Sap in Trees. (By invitation of the Society.)

L. O. Howard: The Shade-tree Question from an Insect Standpoint.‡

Leonhard Stejneger: On the Use of Formaline in the Field.

F. E. L. Beal: The Food of the Cow-bird.

April 4, 1896—259th Meeting.

The President in the chair and forty-five persons present.

The following communications were presented:

V. K. Chesnut: Pfaff's Recent Investigations on *Rhus* Poisoning.

B. T. Galloway: The Action of Copper in Poisoning Fungi.

Barton W. Evermann: The Story of two Salmon.

Frederick V. Coville: Botanical Exploration near the Mexican Boundary.

April 18, 1896—260th Meeting.

The President in the chair and twenty persons present.

The following communications were presented:

W. H. Dall: Exhibition of Skins of the Glacier Bear, *Ursus emmonsi.*

Charles D. Walcott: Preliminary Notes on Middle Cambrian Medusæ.

B. E. Fernow: A Pine Coppice.§

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* Three Editions of Emory's Report, 1848. <Bull. Torrey Bot. Club, vol. 23, pp. 90–92, March, 1896. Three Editions of Stansbury's Report. <*Ibid.*, pp. 137–139, April, 1896.

† Proc. Biol. Soc. Washington, x, pp. 65–83, pls. iv–vi, April 13, 1896.

‡ Yearbook U. S. Dept. Agric., 1895, pp. 361–384.

§ Garden and Forest, viii, p. 472, 1896.

May 2, 1896—261st Meeting.

The President in the chair and thirty-six persons present.

The following communications were presented:

T. W. Stanton: The Genus *Remondia.*[*]

B. T. Galloway: Recent Advances in Our Knowledge of the Plant Cell.

Under the head of Brief Notes—

L. O. Howard exhibited a photograph of three young women who were triplets.

F. V. Coville exhibited a ball three inches in diameter composed of the hairs of *Trifolium incarnatum* taken from the stomach of a horse which had died from this cause.[†]

Erwin F. Smith: The Action of Sunlight on *Bacillus tracheiphilus.*

D. Leroy Topping noted the rediscovery of *Ficaria ficaria* in the original locality in the District of Columbia.

Albert F. Woods: The Action of an Overdose of Hydrocyanic Acid Gas on Tomato Plants.

L. H. Dewey: *Sisymbrium altissimum* as a Tumble Weed.[‡]

May 16, 1896—262d Meeting.

The President in the chair and forty persons present.

The following communications were presented:

The Fauna and Flora of the Islands off the Coast of Southern and Lower California, including the Gulf of California.

Edward L. Greene: The Salient Features of the Flora.

Edgar A. Mearns: The Mammals.

May 30, 1896—263d Meeting.

Dr. William H. Dall in the chair and fifteen persons present.

The following communications were presented:

Theo. Gill: The Characteristics of the Families Salmonidæ and Thymallidæ.[§]

Barton W. Evermann: The Fishes and Fisheries of Indian River, Florida.

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[*] To be published in Proc. U. S. National Museum.

[†] Crimson Clover Hair Balls. <Circular No. 8, Div. of Botany, U. S. Departmeut of Agriculture, pp. 1–4, June 15, 1896.

[‡] Tumbling Mustard (*Sisymbrium altissimum*). <Circular No. 7, Div. Botany, U. S. Dept. of Agriculture, pp. 1–8, 1896.

[§] Science, NS., III, p. 934, June 26, 1896.

October 24, 1896—264th Meeting.

The President in the chair and forty persons present.

The following communications were presented:

C. Hart Merriam: A New Fir from Arizona.*

F. V. Coville: Notice of Britton and Brown's Illustrated Flora of the Northern United States and Canada.

Erwin F. Smith: A Bacterial Disease of Potatoes, Tomatoes, and Egg-plants.†

Under the head of Brief Notes—

Erwin F. Smith exhibited *Leuconostoc* from a sugar vat in Louisiana.

F. V. Coville exhibited *Protococcus nivalis* and *Nymphæa polysepala.*

C. L. Pollard reported *Iresine paniculata* as an addition to the flora of Washington, D. C.

A. F. Woods: The Spotting of Maple Leaves.

B. E. Fernow: Spiny Plants from Arizona.

C. Hart Merriam reported the addition of a rare shrew (*Sorex veræpacis*) from Guatemala to the U. S. National Museum, making the collection of North American shrews complete.

November 7, 1896—265th Meeting.

The President in the chair and forty-four persons present.

The following communications were presented:

Theo. Gill: The Category of Family or Order in Biology.

C. Hart Merriam: Notes on the Fauna of Oregon.

C. Hart Merriam: Supplementary Notes on Tropical American Shrews.

Under the head of Brief Notes—

F. V. Coville spoke of a new Species of *Juncus.*‡

L. O. Howard: *Hymenopterous* parasites of Shade-tree Insects.

November 21, 1896—266th Meeting.

Vice-President L. O. Howard in the chair and forty-seven persons present.

The following communications were presented:

G. H. Hicks: The Mildews (*Erysipheæ*) of Michigan.§

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* Proc. Biol. Soc. Washn., x, pp. 115–118, November 3, 1896.

† Bull. No. 12, Div. of Vegetable Phys. & Path., U. S. Dept. Agriculture.

‡ Proc. Biol. Soc. Wash'n, x, pp. 127–130, November 14, 1896.

§ To be published in vol. xi, Proc. Biol. Soc.

F. V. Coville: The Inflorescence of the *Juncaceæ.*

Theo. Holm: The Alpine Flora of Pikes Peak and Grays Peak, in Colorado.

C. L. Pollard: Some Further Remarks on Britton and Brown's Illustrated Flora.

Under the head of Brief Notes—

F. V. Coville exhibited an Indian bow made of *Taxus brevifolia.*

Theo. Holm showed a number of rare old books, and discussed the derivation of the generic name '*Macounastrum.*'

December 5, 1896—267th Meeting.

Mr. L. O. Howard, representative of the Joint Commission, in the chair.

Annual address of the President, Surgeon General George M. Sternberg: The Malarial Parasite and other Pathogenic Protozoa. (Illustrated by lantern slides.) *

December 19, 1896—268th Meeting.

(Seventeenth Annual Meeting.)

Vice-President L. O. Howard in the chair and twenty-nine persons present.

The annual reports of the Secretary and Treasurer for the year 1896 were presented, and officers for the year 1897 were elected as follows:

President: L. O. Howard.

Vice-Presidents: Richard Rathbun, C. D. Walcott, B. E. Fernow, F. V. Coville.

Recording Secretary: C. L. Pollard.

Corresponding Secretary: F. A. Lucas.

Treasurer: F. H. Knowlton.

Additional Members of the Council: William H. Ashmead, Edward L. Greene, Ch. Wardell Stiles, F. W. True, M. B. Waite.

The following standing committees were appointed by the chair:

On Communications: B. E. Fernow, chairman; F. V. Coville, M. B. Waite, E. A. De Schweinitz, W. H. Ashmead.

On Publications: C. Hart Merriam, chairman; T. S. Palmer, F. H. Knowlton.

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* Public meeting in Builders' Exchange Hall, under the auspices of the Joint Commission, followed by an informal reception and refreshments. Several hundred persons were present.

VOL. X, PP. 1-24 FEBRUARY, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

A REVIEW OF THE WEASELS OF EASTERN NORTH AMERICA.

BY OUTRAM BANGS.

The present paper treats of all the weasels of eastern North America west to and including the Great Plains. There is apparently no portion of this vast region not tenanted by at least one member of this cosmopolitan group. Generally one species occupies a very large area, in the central part of which no others are found, so that when two species occur together it is usually at points where the edges of their ranges overlap. It has been my experience that weasels are nowhere very abundant—never sufficiently so to exhaust their food supply. They are held in check by some natural cause, which may be the parasite that attacks the frontal sinuses of these animals as well as those of their relatives, the skunks, mink, and otter. I have seen skulls in such fearful condition that it would seem as if the animal must soon succumb; still there is no proof that the parasite ever does cause death. *Putorius longicauda* and *P. frenatus* are so free from its attacks that it is rare to find a skull of either badly affected. *P. noveboracensis*, on the other hand, suffers so much that it is hard to get perfect skulls, since many are so distorted that the whole interorbital region is unfit for comparison. As far as I can learn, *P. longicauda* occurs in larger numbers than any of our weasels, while *P. noveboracensis* is apparently not an abundant animal anywhere.

MATERIAL.

Through the kindness of Dr. C. Hart Merriam, Dr. J. A. Allen, Dr. G. Brown Goode, and Mr. William Brewster, I have been enabled to study the eastern weasels belonging to the Department of Agriculture, the American Museum of Natural History, the United States National Museum, and the Museum of Comparative Zoölogy. Dr. C. Hart Merriam, Mr. Gerrit S. Miller, Jr., Mr. Samuel N. Rhoads, and Mr. John H. Sage have also sent me all the skins of weasels in their private collections. These and the large series in the collection of E. A. and O. Bangs comprise a much larger amount of material than was ever before brought together, and enabled me to examine between five and six hundred skins and nearly as many skulls. Of some of the rarer species, as *P. peninsulæ*, *P. rixosus*, and *P. richardsoni*, there are still very few specimens in existence, and these are mostly old, poor, or imperfect. I am much indebted to Mr. Oldfield Thomas, of the British Museum, for comparisons with the supposed types of *P. richardsoni* and *P. longicauda* which are still in that museum, and for sending me specimens of the European species for comparison with ours.

Subgenus GALE Wagner.

Putorius proper, as restricted to the polecats and the ferrets of the old world, is represented in America by *Putorius nigripes* only. All our other weasels belong to the subgenus *Gale*.

The subgenus *Gale* is distinguished from *Putorius* proper by the slender elongate body, terete tail with a decided pencil, and the slightly palmate feet, rather than by any important structural characters. Skulls of the larger American weasels, such as *frenatus* and *longicauda*, are not essentially different from the skull of *Putorius* proper, and there is a regular gradation through *noveboracensis*, where the male skull resembles the *longicauda* group and the female skull the *richardsoni* group, down to the little, light, smooth skull of *rixosus*, which represents the extreme of differentiation of *Gale*.

VARIATION.

Sexual variation.—The great difference in size between the sexes of all the species of *Putorius* is now well known, but in no group is it so marked as in the subgenus *Gale*. The different species vary in this respect: in *P. noveboracensis* the difference is greater than in any of the others, while in *P. longicauda* the sexes are more nearly alike. In adult examples of *P. noveboracensis* the male averages about eighty millimeters more in total length than the female, while in *longicauda*, which is a larger animal, the difference is about sixty millimeters. This sexual difference in size must always be kept in mind in trying to identify weasels, since it may give rise to a great deal of trouble, especially in skins made up by inexperienced collectors, who are unable to determine the sex of their specimens.

Apart from the difference in size, the sexes of most weasels are alike, *noveboracensis* being the only one to show other sexual characters (in this species there is a well marked sexual difference in the skull apart from size).

Variation with age.—Weasels vary much in size with age, continuing to grow for at least a year, and probably after the age can be told by the skull. Very young weasels in the first summer have the tails rather short, the hair of the tail very short and appressed, and the tail tapering off to a point without any decided pencil. In this condition the tail has a very different look from that of the adult. The color of the under parts is often more yellow or buffy in the young than in the adults, but on the whole the young and old do not differ much in external appearance.

The skull of course varies greatly with age. In young skulls the brain case always looks very large, round, and deep. By actual measurement, however, it is about as in the adult, and as the animal increases in age the rest of the skull grows up to it. The whole rostral portion of the skull is slender and small in the young and gradually becomes broader and heavier as the animal grows older. This change takes place slowly and seems to continue over a long period. Very old examples of any species, but especially of *P. richardsoni* and *P. r. cicognani*, show very broad, heavy rostrums. This is often the surest mark of great age, which a worn and broken condition of the teeth by no means always indicates. All the species of the *longicauda* group and the male of *P. noveboracensis* develop strong sagittal crests with age, while the members of the *richardsoni* group and the female of *P. noveboracensis* keep quite smooth and show only a slight indication of a sagittal crest. The sutures all close very early, and the skull has the appearance of age long before it has attained full size.

Individual variation.—The range of individual variation in color is slight and unimportant. In some forms, noticeably in *P. rich-*

ardsoni cicognani, there is a wide range in size. Just how much of this is due to age and how much to individual variation is hard to tell, as there is in this subspecies a constant increase in size from south north, examples from Minnesota and northern New Brunswick and northward being much larger than those from Massachusetts and Connecticut.

EARLY HISTORY OF THE SPECIES.

The first work that need be taken into consideration in studying our weasels is the *Fauna Boreali-Americana* of Richardson, published in 1829. In this the author described two species and gave them the names of the common European weasels, *vulgaris* and *erminea*. The latter he divided into two varieties, a large long-tailed one from Carlton House, Saskatchewan, and a large short-tailed one from Fort Franklin, Great Bear lake.

Bonaparte, in his *Fauna Italica* (fasciculus xxii), published in 1838, described a new weasel from the United States which he called *Mustela cicognani*. This was the same animal that Richardson had called *M. vulgaris*. The same year, in Charlesworth's Magazine, Bonaparte named Richardson's two varieties of *erminea* as distinct species, calling the long-tailed one from Carlton House *Mustela longicauda*, and the short-tailed one from Great Bear lake *Mustela richardsoni*. The next year (1839) Richardson, in the 'Zoölogy of Beechey's Voyage,' accepted Bonaparte's conclusions as stated above.

De Kay in 1840, in his 'Report on the Zoölogy of New York,' named a new weasel which he called *Putorius noveboracensis*. He gave no description and his name is a *nomen nudum*. Emmons, the same year (1840), in his 'Report on the Quadrupeds of Massachusetts,' described *P. noveboracensis*, attributing it to De Kay. Of course the name must date from Emmons. It is rather unfortunate, as Emmons gives no type locality. As he was treating only of Massachusetts mammals, it seems advisable to consider Massachusetts the type locality.

Audubon and Bachman in 1842, in the 'Journal of the Academy of Natural Sciences of Philadelphia,' described *Mustela fusca*, which is the same as *M. cicognani* of Bonaparte.

De Kay, in his 'Zoölogy of New York' (1842), in addition to *P. noveboracensis* gives *M. fusca* of Audubon and Bachman, and describes another weasel that he calls *Mustela pusilla*. All but the first are synonyms of *cicognani* Bonaparte.

Audubon and Bachman's 'Quadrupeds of North America' appeared in three volumes, from 1851 to 1853. In this work are given five species of weasels, namely, *Putorius ermineus*, *P. agilis*, *P. fuscus*, *P. pusillus*, and *P. frenatus*. Their *ermineus* and *agilis* are *noveboracensis* (the former the male and the latter the female). Their *frenatus* was a combination of *frenatus* and *xanthogenys.*

In 1857 appeared Professor Baird's great work, 'The Mammals of North America.' He gave six species of weasels as inhabiting eastern North America, namely, *P. noveboracensis*, *P. richardsoni*, *P. cicognani*, *P. pusillus*, *P. longicauda*, and *P. frenata*. All his species were correct except *richardsoni.* This animal he had never seen, and not being aware of the great sexual difference in size, he referred the smaller examples of *noveboracensis*, probably females, to it. His *Putorius pusillus* is the *P. rixosus* of the present paper, he wisely thinking that it was not the *M. pusilla* of De Kay. His *frenatus* was the true *frenatus* of Lichtenstein.

After Baird came a period of great confusion, authors giving all the species or nearly all accorded to eastern North America by Baird from any one locality they happened to be writing about.

Samuels, in his list of the 'Mammals of Massachusetts' (1861–1862), gave four species as inhabiting that State, namely, *richardsoni*, *cicognani*, *pusillus*, and *noveboracensis.* Of course these four were the males and females of our two common species, *cicognani* and *noveboracensis.*

Dr. Gilpin, in his 'Mammals of Nova Scotia' (1866), gave *P. richardsoni*, *P. noveboracensis*, and *P. cicognani* as inhabitants of that province. In reality there is but one weasel in Nova Scotia, and that is *P. cicognani.* I have examined nearly all the skins Dr. Gilpin sent to the United States National Museum and find them labeled *richardsoni* and *cicognani*, according to size. The measurements he gave for the specimen he called *noveboracensis* indicate a total length 100 millimeters greater than the largest male *noveboracensis* I ever measured and are probably erroneous.

Gray, in an article in the Proceedings of the Zoölogical Society of London for 1865, with his usual disregard for all previous names, gives two new ones, namely, "*Putorius erminea*, var. *americana*," which includes *P. longicauda* and *P. noveboracensis;* and for *P. cicognani*, "*Mustela (Gale) vulgaris*, var. *americana.*" Fortunately neither of these names can stand. He based *P. richardsoni* on Baird; the animal is, as already stated, *P. noveboracensis.* In 1869 Gray arranged the American weasels in the same way in his 'Catalogue of the Carnivora in the British Museum.'

The next paper of importance is Allen's list of the 'Mammals of Massachusetts' (1869). Allen degraded all the species of previous authors and lumped all our weasels under the names *Putorius erminea* and *Putorius vulgaris*, allowing *P. frenatus* to stand as a doubtful form.

In 1877 appeared Coues' Fur-bearing Animals. In this work the author recognized four weasels in the whole of North America, namely, *vulgaris*, *erminea*, *longicauda*, and *brasiliensis frenatus*. This arrangement has been followed by most subsequent authors.

The species of the subgenus *Gale* inhabiting eastern North America may be arranged in three groups as follows:

1. Skull large and heavy, much constricted just back of postorbital processes, and developing a strong sagittal crest; postorbital processes well developed; inflated squamosal much reduced .... *Neogale* Gray.*

Name of species.	Type locality.
Putorius longicauda (Bonaparte)	Carlton House, Saskatchewan.
longicauda spadix subsp. nov.	Fort Snelling, Minn.
brasiliensis frenatus (Licht.)	Valley of Mexico.
peninsulæ Rhoads	Hudson's, Pasco Co., Fla.

2. Skull of male developing sagittal crest; that of female smooth. Inflated squamosal much more reduced in the male than in the female; postorbital processes well developed in both sexes.

noveboracensis Emmons	Massachusetts.

3. Skull light and smooth, not sharply constricted back of postorbital processes; developing only very slight sagittal crest; postorbital processes not well developed; inflated squamosal large and much inflated .... *Gale* Wagner.

richardsoni (Bp.)	Fort Franklin, Great Bear lake.
richardsoni cicognani (Bp.)	Eastern United States.
rixosus sp. nov.	Osler, Saskatchewan.

KEY TO THE WEASELS OF EASTERN NORTH AMERICA (IN SUMMER PELAGE).

Pelage coarse and harsh.
  Tail less than half as long as head and body; a tuft of white hairs in front of ear and sometimes an indistinct white patch on forehead............................ *peninsulæ*.

**Neogale* was proposed by Gray for the bridled weasels on account of the peculiar black and white facial markings. *P. longicauda* also belongs to this group, which is almost worthy of subgeneric rank.

Tail more than half as long as head and body; head with distinct black and white markings or wholly unmarked.
  Head with distinct black and white markings......*frenatus.*
  Head without black and white markings.
    Upper parts light brown or clay color............*longicauda.*
    Upper parts dark rich brown ....*spadix.*

Pelage fine and soft.
  Tail not tipped with black; size smallest...............*rixosus.*
  Tail tipped with black; size medium or large.
    Tail almost half as long as head and body; feet usually without white markings..........................*noveboracensis.*
    Tail about one-third as long as head and body; feet usually with white markings.
      Under side of tail concolor with back; tail vertebræ in adult male about 80 millimeters.............*cicognani.*
      Under side of tail concolor with belly; tail vertebræ in adult male about 100 millimeters............*richardsoni.*

Putorius longicauda (Bonaparte). Long-tailed Weasel.

Pl. I, figs. 1, 1*a;* II, figs. 1, 1*a;* III, figs. 1, 1*a*.

Mustela (*Putorius*) *erminea* Rich., Fauna Boreali-Americana, 46–47, 1829 (in part: the long-tailed variety from Carlton House).
Mustela longicauda Bonap., Charlesw. Mag. Nat. Hist., II, p. 38, Jan., 1838.
  No description, but based on Richardson's long-tailed variety of *erminea* from Carlton House, Sask. (Rich., Fauna Boreali-Am., 1, p. 47, 1829).
Putorius longicauda Rich., Zoöl. Beechey's Voyage, p. 10,* 1839.
  Baird, Mamm. N. Am., p. 169, 1857.
  Coues' Fur-bearing Animals, p. 136, 1877; and of most subsequent authors.

Type locality.—Carlton House, Saskatchewan. The supposed type, a specimen in winter pelage, is in the British Museum.

Geographic distribution.—Northern plains from Saskatchewan and Alberta, south at least to Nebraska and Kansas, west to the Rocky mountains, and east only to the western edge of the eastern forest belt in Minnesota. Apparently abundant throughout its entire range. Inhabits parts of the Canadian, Transition, and Upper Sonoran Zones.

General characters.—Size very large; tail very long, more than one-third of total length, with the black tip short, often scarcely more than the pencil; claws long, sharp, and curved; coat in summer pelage coarse and harsh.

Color.—Summer pelage: Upper parts pale yellowish brown, varying individually from strong tawny to clay color, rather darker on top of head and sides of nose; under parts yellow (varying from buff yellow and maize yellow to pale ochraceous and saffron yellow); line of demarkation between colors of upper and under parts distinct and straight along the sides, color of under parts extending down inside of legs and covering the whole fore feet and toes and inside half of upper surface of hind feet; chin and upper lips white; tail same color as upper parts, sometimes a little paler below than above, becoming suddenly black at tip, and ending in a long pencil of black hairs; under fur a shade or two lighter than the long hairs. Winter pelage: Pure white all over, with no yellowish tinge; end of tail jet black. The change to a white winter coat apparently takes place over the entire range of the species.

Size.—Average of five adult males from Alberta and Saskatchewan: total length, 445.5; tail vertebræ, 161; hind foot, 51.5. Average of five adult females from Alberta, Saskatchewan, and North Dakota: total length, 385; tail vertebræ, 139; hind foot, 43.5.

Skull.—Short, broad, and massive, developing with age a strong sagittal crest; general shape of brain case, viewed from above, triangular, owing to great width across mastoids and sharp constriction behind postorbital processes; postorbital processes well developed and conspicuous; audital bullæ broad, deep, and short; inflated squamosal much reduced and not nearly flush with under surface of audital bullæ; distance from audital bullæ to postglenoid process very short; mandible large and heavy.

The skull of *P. longicauda* resembles the skull of *Putorius* proper more than that of the smaller members of the subgenus *Gale.*

The dentition is normal, but rather heavy.

Remarks.—*Putorius longicauda* is easily told from all other North American weasels. Its highly developed desert coloration, large size, and long, graceful tail make it one of our finest species. Specimens from Devil's lake, North Dakota, while referable to this species, are rather darker than true *longicauda* and are approaching its eastern subspecies *spadix.*

P. longicauda and its allies seem to be less subject to the attacks of the parasite that lives in the frontal sinuses of all the weasels than the other members of the subgenus *Gale.* The sexual difference in size is not so great in *P. longicauda* as in most of the other species.

Putorius longicauda spadix subsp. nov.

Type from Fort Snelling, Minn., No. $\substack{3265\\1786}$, male, yg. ad., American Museum Nat. Hist., New York, col. by Dr. E. A. Mearns, U. S. A., June 25, 1889. Original number, 812.

Geographic distribution.—The western edge of the eastern forest belt in Minnesota (Fort Snelling and Elk river). The subspecies probably ranges north and south of this region. Further west, where the open, treeless plains are reached, it passes into true *longicauda.*

General characters.—Similar to true *longicauda*, from which it differs in color only.

Color.—Summer pelage: Upper parts Prout's brown, not very different from the color of *P. noveboracensis*, but perhaps a little brighter—very different from the yellowish and clay color of true *longicauda.* Under parts in the type white, with a faint greenish yellow tinge. In two topotypes

(Nos. $\frac{3263}{1785}$ and 3264, American Museum Nat. Hist.) the belly is buff yellow, and in a skin from Elk river, Minn. (No. 31891, Dept. of Agric. coll.), it is strong buff yellow. All but the type, however, are immature, and the under parts of all are much lighter than in true *longicauda* of the same age. The line of demarkation, owing to the much darker upper and lighter under parts, is very much more distinct than in *longicauda*; it runs in an even line straight along the side. The color of the under parts covers the inside of the legs, under surface of the arms, and the whole of the hands and toes; upper lips and chin, white; tail, same color as back, with a short, black end, and also a long pencil of black hairs; under fur, same color as the long hairs. Winter pelage: Pure white, with no yellowish tinge; end of tail jet black.

The change to a winter white coat takes place over the entire range of the subspecies.

Size.—Type, male, yg. ad.: Total length, 445; tail vertebræ, 160; hind foot, 55. Average of five adult males from Fort Snelling and Elk river, Minn.: Total length, 467; tail vertebræ, 171; hind foot, 54. An adult female topotype measures: total length, 375; tail vertebræ, 123; hind foot, 42.5.

Skull.—Same as in true *longicauda*.

Remarks.—*Putorius spadix* is the dark-colored eastern race of *longicauda*. It seems to inhabit only a small area along the western edge of the eastern forest belt. In color it very closely resembles *P. noveboracensis*, from which it can easily be told by the white feet, longer tail with shorter black tip, and the harsh pelage; and with as great certainty by the skull, which is the same in all its characters as that of true *longicauda*.

Putorius brasiliensis frenatus (Licht.). Bridled Weasel.

Mustela frenata Lichtenstein, Darstell. neuer o. wenig bekannt Saugth., pl. XLII and corresponding text, 1832.

Putorius frenata Aud. and Bach., Quad. N. Am., II, p. 71, 1851 (in part; not plate LX).

Putorius frenatus Baird, Mamm. N. Am., p. 173, 1857. Mex. Boundary Surv., part II, Rept. on Mammals, p. 19, 1859.

Putorius (*Gale*) *brasiliensis frenatus* Coues, Fur-bearing Animals, p. 142, 1877 (part).

Type from vicinity of the city of Mexico.

Geograghic distribution.—Table-land of Mexico from city of Mexico northward to southeastern Texas (north at least to San Antonio and probably east along the coast to Louisiana).

General characters.—Size, largest of all our weasels, tail forming nearly half of the total length and with a short, black tip; hair rather short and coarse; conspicuous black and white markings on the head.

Color.—Upper parts light brown, varying from russet to raw umber, gradually darkening just back of the ears to black; a large spot between the eyes and two larger bands extending from the throat up between the ear and the eye, white. These markings are very variable. Sometimes the bands are very broad and meet the white spot between the eyes, making a continuous white band around the head; sometimes they are reduced to a few white scattering hairs between the eyes and narrow and broken bands of white in front of the ears. The rest of the head, the ears, nose, and whiskers are black; under parts uniform, strong orange buff, sometimes tinged with ocher yellow; line of demarkation between colors of upper and under parts a little irregular and rather high up; hands, toes, and inside of feet a shade or two lighter than the under parts, but not white; chin and a very narrow border to upper lips white; tail same color as upper parts, its black tip short; under fur same color as long hairs; no seasonal change in color.

Size.—Average measurements of five adult males from Brownsville, Texas: total length, 499; tail vertebræ, 224; hind foot, 46. Average of three adult females from Brownsville, Texas: total length, 412.5; tail vertebræ, 172; hind foot, 36.5.

Skull.—Large and massive, but not differing in any essential characters from that of *P. longicauda;* it is larger and even more constricted back of the postorbital processes, and has a tendency to become more roughened in old age by muscular impressions.

This weasel, like all the *longicauda* group, is very free from the parasite that preys on the frontal bones; dentition normal, but heavy.

Remarks.—The geographic distribution of this weasel is still imperfectly known. In all probability the form has a much wider range than is actually shown by existing specimens. Probably, like many Mexican mammals, it extends east along the Gulf coast to the shores of Louisiana. Its western limit is not known.

Putorius peninsulæ Rhoads. Florida Weasel.

Pl. I, fig. 5; II, fig. 5; III, fig. 5.

Putorius peninsulæ Rhoads, Proc. Acad. Nat. Sci. Phila., p. 152, 1894.
Chapman, Bull. Am. Mus. Nat. Hist., p. 345, 1894.
Putorius erminea Chapman, Bull. Am. Mus. Nat. Hist., p. 345, 1894.

Type locality.—Hudson's, Pasco Co., Florida.

Geographic distribution.—The whole of peninsular Florida and probably north into Georgia and the lowlands of South Carolina; inhabits the tropical fauna of Florida and perhaps the Austroriparian zone also.

General characters.—Size medium; tail short; very much shorter than in any other member of the *longicauda* group (less than one-third the total length) and tipped with black for about one-third its length; hair on the tail very short, making the tail look slender; feet slender and sparsely haired; the nails very conspicuous; coat everywhere short, coarse, and very lustrous.

Color.—Upper parts, hair brown, with a slight olivacious tinge in a fine specimen from Tarpon Springs (No. 2379, coll. S. N. Rhoads); burnt umber in a specimen from Osceola, Florida (No. 7929, coll. Am. Mus. Nat. Hist.), other skins varying between these two extremes; some white hair on the forehead and behind the eyes, varying in amount in different specimens, from large and well defined white markings in the type* to only a few hairs in the Osceola skin; a conspicuous patch of long white hair in front of opening of ear; under parts pale yellow (primrose yellow to pale buff yellow); line of demarkation between colors of upper and under parts high up and rather irregular. The color of the under parts covers under side of arms and whole of hands and extends down inside of legs, covering toes and inside half of upper surface of feet; upper lips and chin and under side of head back as far as the jaw white; tail same color as back, gradually shading to black at the tip, with a short black pencil; no seasonal change in color.

Size.—The size of the male of this weasel is a matter of doubt. An old adult breeding female from Tarpon Springs (No. 2379, coll. of S. N. Rhoads) measures: total length, 374; tail, 127; pencil, 20; hind foot, 44.5 (measured in flesh by W. S. Dickinson).†

Skull.—The skull of *P. peninsulæ* is quite different in many particulars from that of any other weasel I have examined, but clearly places the species in the *longicauda* group. It is large and massive, developing a strong sagittal crest with age; brain case very large and deep (viewed from above triangular with the great construction back of postorbital process and breadth across the mastoids of all the *longicauda* group); postorbital processes well developed; inflated squamosal more reduced than in any of our species, not excepting *longicauda;* audital bullæ extremely large, broad, and deep; mandible short and very heavy.

The dentition is much heavier throughout than in other species of about the same size, with the exception of the last upper molar, which is smaller. For instance, the old adult skull from Tampa bay, although smaller than male skulls of *noveboracensis* or *longicauda* of the same age, shows all the teeth to be actually larger, except the last upper molar, which is smaller than in either of these species.

Remarks.—Mr. Rhoads first described this remarkable weasel from a single unsexed skin, accompanied by the rostral portion of the skull and the whole lower jaw. He considered the specimen an adult female. It probably is a female, as it is about the size of the Tarpon Springs specimen, but is far from adult, as shown by the fact that the sutures are still plainly visible and the teeth unworn. One of the characters he gives is the position of the lower incisors, which are so crowded as to throw the second incisor of each mandible behind the other incisors, giving the appearance of a double row of teeth. This condition is merely individual, and is not shown in other skulls of *peninsulæ*. It can be found in many examples of any species.

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* In the type these markings may be exaggerated by albinism, as it has a large, irregular white spot in the middle of the back and a white line on top of the head between the ears, a place where albinism in mammals usually shows itself.

† The measurements of the type taken from the dried skin, and therefore unreliable, are: total length, 375; tail vertebræ, 100; hind foot, 40.

In the American Museum collection is a skin (No. $\frac{1245}{8616}$), with, unfortunately, only a fragment of the skull left, from Yemassee, in the southeast corner of South Carolina, which I refer with some doubt to *P. peninsulæ*. The specimen is labeled male. The skin is much shrunken and affords no actual measurement, except that of the hind foot, which is 41 millimeters, one millimeter more than in the type of *P. peninsulæ*, also measured from the dry skin. The colors are about as in *peninsulæ*, but the tuft of white hair in front of the ear is not present, and the yellow of the under parts, while covering the whole hand and inside of the arms, does not extend down the legs, but ends about the middle of the thighs, as in *noveboracensis*. The toes, however, are yellow. The fragment of skull has the teeth; they are a trifle heavier than in the average males of *noveboracensis*, while the animal is evidently smaller and has a shorter tail.

All the existing specimens of *peninsulæ* are very nearly of a size. If both sexes are represented, *peninsulæ* is remarkable for the slight difference in size between the male and the female. Male weasels always greatly outnumber the females, and it would be strange if all the seven examples of *peninsulæ* were females. This is a point of great interest, and can only be settled by properly sexed and measured male specimens, which I hope will turn up before long, as I believe that *P. peninsulæ* is far from a rare animal in Florida. I heard of it several times at Micco, where it is apparently not uncommon, but was able to get only the skull referred to below.*

I have been told by a reliable man, who used to live in south central Georgia, that a weasel is common there, and that he frequently caught them when trapping for other animals. Of course, he could not tell the species, but I fancy it is *peninsulæ*.

P. peninsulæ is known at present by only a few rather fragmentary and one good sexed and measured specimens, as follows: The type, No. 1515, coll. S. N. Rhoads, from Hudson's, Pasco county, Florida (a rather young, unsexed, and unmeasured skin, with a small part of the skull); No. 61490, U. S. Nat. Mus., from Polk county, Florida, winter 1893–1894, N. R. Wood, collector (good skin, without sex or skull); No. $\frac{3177}{6544}$, coll. Dr. C. Hart Merriam, from Tampa bay, Florida (an old adult, a poor unsexed and unmeasured skin, with a rather more perfect skull than the type, only the occipital part being gone); No. 7927, Amer. Mus. Nat. Hist., from Osceola, Florida (a good but unsexed and unmeasured skin, with no skull); No. 3053, coll. E. A. and O. Bangs, from Micco, Florida (a nearly perfect, rather young skull); No. 2379, coll. of S. N. Rhoads (a fine adult breeding female, with the six mammæ plainly visible in the skin, taken November 11, 1895, at Tarpon Springs, Florida, by W. L. Dickinson, with a nearly perfect skull), and No. $\frac{1245}{8616}$, Amer. Mus. Nat. Hist., from Yemassee, in the lowlands of South Carolina.

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* The great difficulty is in trapping successfully in Florida with any kind of baited trap. Where there are hogs this is practically impossible, and in other places turkey buzzards, opossums and raccoons make the trapper's life a burden.

Putorius noveboracensis Emmons. New York Weasel.

Pl. I, figs. 2, 2*a;* II, figs. 2, 2*a;* III, figs. 3, 3*a*.

Putorius noveboracensis DeKay, New York Survey, p. 18, 1840 (*nomen nudum*). Zoölogy of New York, Mammalia, p. 36, 1842.
Emmons, Rept. Quad. Mass., p. 45, 1840.
Baird, Mammals N. Am., p. 166, 1857.
Samuels, Ann. Rept. Agric. Mass., p. 156, 1861–1862.
Putorius erminea Thompson, Nat. Hist. Vermont, p. 31, 1842.
Aud. and Bach., Quad. N. Am., II, p. 56, plate LIX, 1851.
Putorius agilis Aud. and Bach., Quad. N. Am., III, p. 184, plate CXL, 1854 (the female, not *Mustela agilis* of Tschudi).
Putorius richardsoni Baird, Mamm. N. Am., p. 164, 1857 (probably the female).
Samuels, Ann. Rept. Agric. Mass., p. 155, 1861–1862.
Mustela erminea Var. *Americana* Gray, P. Z. S., p. 111, 1865 (part); Cat. Carnivora, British Mus., p. 89, 1869 (part).
Mustela richardsoni Gray, P. Z. S., p. 112, 1865 (based on Baird); Cat. Carnivora, British Mus., p. 90, 1869 (based on Baird).
Putorius ermineus Allen, Bull. Mass. Comp. Zoöl., 1, p. 167, 1869 (part); Proc. Bost. Soc. Nat. Hist., XIII, p. 183, 1869.
Putorius (*Gale*) *erminea* Coues, Fur-Bearing Animals, p. 109, 1877 (part), and of most subsequent authors.

Type locality.—State of Massachusetts.

Geographic distribution.—Eastern United States from southern Maine, southern New Hampshire, and southern Vermont south to North Carolina (Raleigh, N. C.) and probably farther; west at least to Indiana and Illinois (Denver, Ind., and Warsaw, Ill.). Inhabits the Carolinian and Transition zones of the east and just touches the lower part of the Canadian zone. Apparently very rare at the northern and southern extremes of its range and attaining its greatest abundance in lower Transition and upper Carolinian country.

General characters.—Size large; tail long (more than one-third of the total length), with the black end from one-third to one-half the length of the tail; feet slender and small; pelage full and soft.

Color.—Summer pelage: Upper parts rich, deep reddish brown, varying from Prout's brown to Vandyke brown, generally rather darker along the middle of the back; under parts white to pale yellow (usually white in northern examples and yellow in southern); line of demarkation between colors of upper and under parts very irregular and low down, often leaving only a narrow band of white along the middle of the belly. This white band frequently encloses spots of brown. The color of the under parts generally extends half way down the inside of the thighs and to the wrists, the whole of the feet and upper sides of arms and hands being brown. The upper lips are usually but not always brown (in some examples they are broadly edged with white, as in *richardsoni* and *cicognani*).

The tail is the same color as the upper parts for about half its length, then begins gradually to darken, and is tipped with black; under fur the same color as long hairs. Winter pelage: The winter pelage is white or brown, according to latitute; it is white only in the northern part of the animal's range.* In the brown winter pelage the color is usually about the same as in summer, but the coat is, of course, much longer and fuller. I have seen a few winter skins that had not turned white, but were much lighter than the usual summer pelage. One of these (No. 2184, collection S. N. Rhoads, Chester county, Penn., December 16, 1890) has the whole upper parts a beautiful pale drab which fades almost insensibly into the white of the under part. In the white winter pelage the animal is white all over, with generally a yellowish tinge on the posterior half of the upper parts and the whole of the under parts, and with a conspicuous black tip to the tail, usually covering about one-third of its length.

Size.—Average of ten adult males from lower Transition zone: total length, 407; tail vertebræ, 139.5; hind foot, 47. Average of ten adult females from lower Transition zone: total length, 324.5; tail vertebræ, 108; hind foot, 34.5.

Skull.—There is great sexual difference, in addition to that of size, in the skulls of *P. noveboracensis,* which seems peculiar to this species. The postorbital processes are well developed in both sexes. The male skull is large and develops a sagittal crest with age; the general shape of the brain case, viewed from above, is less triangular than in the *longicauda* group, being not so sharply constricted back of the postorbital processes and rather narrower across the mastoids; the audital bullæ are large and deep; the inflated squamosal is much reduced, but usually not quite to the same extent as in the *longicauda* group. The female skull is small and does not develop a sagittal crest; the general shape of the brain case, viewed from above, is nearly oblong, as in the *richardsoni* group; the inflated squamosal is large and much inflated and nearly flush with the lower surface of the audital bullæ; the audital bullæ and inflated squamosal meet in a rounding line (in the *richardsoni* group this line is usually straight). The female skull can be told from that of any of the *richardsoni* group with great certainty by its well developed postorbital processes.

The dentition is much heavier in the male than in the female, the difference being more marked than in other species.

Remarks.—*P. noveboracensis* is very generally distributed over the Atlantic tier of States from North Carolina to New Hampshire. It is the only weasel found in the Carolinian zone, but begins to overlap the range of *P. richardsoni cicognani* in Connecticut and New York, and thence northward gradually gets rarer as *cicognani* becomes commoner, until in the Canadian zone we have *cicognani* alone.

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* In northern New York and Vermont *P. noveboracensis* always assumes a white winter coat. In northern Massachusetts it sometimes does. I have two specimens, caught in the same trap at Wayland, Mass., one January 11, 1875, in the white pelage and the other January 12, 1875, in the brown pelage. In central Connecticut it never changes, as shown by large series from Liberty Hill, Conn., taken all through the winter, from October to March.

There is a slight variation in the color of the under parts, which to a certain extent is geographical, for southern examples as a rule have the belly yellow and northern ones have it white, but the difference is not altogether constant, and does not warrant dividing *noveboracensis* into two races.

It is unfortunate that DeKay cannot have the credit of naming this weasel, and still more so since we know that Emmons and DeKay were fast friends, and that Emmons meant to give him full credit of his discovery. The type locality of *P. noveboracensis* must, I think, be considered to be Massachusetts although Emmons in describing it mentions no locality in that State, nor even the State itself, but says only : " It is common to the middle and northern States." Of course, Emmons was writing only of the mammals of Massachusetts, which fact may be assumed to tie the type locality down to that State.

The male *noveboracensis* is more often seen than the female, and appears to be much commoner. In examining large series of weasels of any species one is always struck by the great preponderance of males, outnumbering the females about 5 to 1. There may be, however, some other cause to account for this, since the males are perhaps easier to trap or more active or courageous and therefore more often seen and killed ; hence an examination of skins alone may give a false idea of the relative numbers of the sexes.

The sexual difference in size is very striking in *P. noveboracensis.* The male is a large and powerful weasel and does not hesitate to attack and kill animals the size of the cotton-tail rabbit and the domestic hen, while the female is such a little slender creature that it seems almost incredible that she can nurse and bring up a litter of males each of which soon grows to be much larger than herself. On June 5, 1894, some men at work on our place, at Wareham, Massachusetts, saw three weasels of this species cross a road and go into a stone wall. They immediately ran for a gun, and by imitating the squeaking of a mouse succeeded in attracting one, the adult female, out of the wall and shot her. I saw that she had been nursing, and placed some steel traps along the wall in positions where the other two would go into them when they came back that way, as they were sure to do. The morning of June 9 I had them both. They were males, and although still retaining their milk teeth, each was very much larger than his mother.

Putorius richardsoni (Bonaparte). The American Ermine.

Pl. I, figs. 3, 3*a*; II, figs. 3, 3*a*; III, figs. 6, 6*a*.

Mustela richardsoni Bonaparte, Charlesw., Mag. Nat. Hist., II, p. 38, Jan. 1838 (based on specimen from Fort Franklin, Great Bear lake, Rich., F. B. A., p. 47, 1829).
Rich., Zoöl. Beechey's Voy., p. 10,* 1839 (not *Putorius richardsoni* Baird).
Putorius (*Gale*) *erminea** Coues, Fur-bearing Animals, p. 109, 1877 (in part).

Type locality.—Fort Franklin, Great Bear lake. The supposed type, a specimen in winter pelage, is still in the British Museum.

Geographic distribution.—Arctic America east at least to Fort Albany, on the west coast of James bay, and thence northwest to Alaska, where it reaches the Pacific coast. Whether *richardsoni* reaches the Atlantic coast or not is still a matter of doubt, but if it does it must be in the extreme north.* Apparently abundant over the whole of this vast region and probably shades into *cicognani* in the transcontinental forest belt at the south of its range.

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* The name of the European ermine or stoat has appeared a good deal in our literature, but wholly without warrant. In 1869, in his Catalogue of the Mammals of Massachusetts, Dr. J. A. Allen attempted to prove that all our weasels, excepting the bridled weasel and what he called *P. vulgaris* (probably a mixture of *cicognani* and *rixosus*) belonged to the European species, *P. erminea*. Doctor Allen never mentioned the crania of any of the weasels of which he treated and appears never to have consulted them, but went blindly ahead in an attempt to prove a preconceived theory—that all the carnivora of Europe, Asia, and North America were the same. One land bear, one wolf, one red fox, one mink, one ermine, and one weasel is what he allowed to the whole northern hemisphere. He was substantially followed by Dr. Coues, in his Fur-bearing Animals, in 1877, with the exception that Coues recognized *P. longicauda* as distinct. Since then the name *P. erminea* has been frequently used for American weasels of very different species.

There is really no need for confusing the European ermine and various closely related species or subspecies with any of our weasels. The only North American species that resemble it are *richardsoni* and *cicognani*, but from either of these it can be recognized at once by much larger size and by the greater extent of black on the tail and the immensely long pencil. The skull can be told from any North American member of the subgenus *Gale* at a glance. The brain case is shallow behind, with narrow supraoccipital. The audital bullæ are shallow and flat and the basioccipital broad. The skull can be distinguished by these peculiarities and its much greater size from any of our species with inflated squamosals. These are the only ones it need be compared with.

General characters.—Largest of the short-tailed American weasels. Tail short (a little more than one-fourth of the total length), tip black, pencil long and bushy; feet, large and broad; coat, very long, full, and soft.

Color.—Summer pelage: Upper parts pale yellowish brown, ranging from nearly raw sienna to nearly raw umber and intermediate shades, only a little darker than the upper parts of *P. longicauda*, under parts varying from primrose yellow to maize yellow; line of demarkation between colors of upper and under parts high up, straight and unbroken. Color of under parts covers under side of arms and hands, inside of legs and toes; upper lips and chin white; tail above, same color as back; below, same color as belly (usually all the way down to the black tip). This yellow under side of the tail is peculiar to this species, so far as I know, and is shown by every specimen except one that I have examined. This one is an adult breeding female (No. 4349, U. S. Nat. Mus.) from Fort Albany, James bay. It has the under side of the tail not yellow, but yet lighter than the upper side. This specimen is the most southerly and easterly example of *richardsoni* that I have seen and is probably shading toward *cicognani*. The under fur is the same color as the long hairs. Winter pelage: Pure white all over, often tinged with yellow on the tail, hind quarters, and belly; end of tail, for a little more than pencil, jet black; coat extremely long and full; feet very heavily furred. The change to a white winter coat takes place over the entire range of the species.

Size.—The type, evidently a male, although no sex was given, measured: head and body, 11 inches (280 mm.); tail, 4 inches (102 mm.). The only other specimens measured in the flesh are two in the United States National Museum. One of these (No. 5696, from Fort Simpson, December 20, 1860, male, Bernard R. Ross) measured: head and body, 10.30 inches (261.5 mm.); tail, 4.25 inches (107.5 mm.); hind foot, 1.70 (43 mm.). The other (No. 2065, "Barren Grounds," June 28, 1864, male, McFarlane) measured: "extreme length," 13 inches (330 mm.).

Skull.—Skull smooth and light, without pronounced sagittal crest, although in very old examples there is a slight sagittal development; general shape of brain case, viewed from above, oblong, owing to great breadth across interorbital region and relatively short distance across mastoids; postorbital processes short, blunt, and not well developed; audital bullæ long and deep and meeting the inflated squamosal in almost a straight line; inflated squamosal large, much inflated, and almost flush with audita bullæ; distance from audital bullæ to post-glenoid process much greater than in the large weasels of the *longicauda* and *noveboracensis* groups.

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* On page 149 of Appendix No. IV, vol. II of Ross' Voyage, 8vo, 1819, is a description of a weasel killed at the west side of Baffin's bay. The description is quite minute, and the measurements given are: "From the tip of the nose to the insertion of the tail, eight inches and a half [= 218 mm.]; to the tip of the tail, eleven inches and a half [= 292 mm.]." The breast and belly are said to be yellow. The sex is not given.

The skulls of the weasels of this group differ more widely from those of *Putorius* proper than do skulls of the *longicauda* group or of the male *noveboracensis.*

Remarks.—When Professor Baird wrote his 'Mammals of North America' he had never seen a specimen of *richardsoni*, the animal he called *richardsoni* being the small examples of *noveboracensis*, probably females. Since that time the National Museum has accumulated a large series of this interesting weasel, but most of the skins are in poor condition, unmeasured, unsexed, and accompanied only by fragmentary skulls, which are inside the skins. Still there are a few skulls in good condition accompanying the skins taken in Alaska by the indefatigable Nelson; measurements of these are given in the tables. A large proportion of the known skins came from points in Alaska, but there are many from stations that completely surround the type locality from Fort Albany to Franklin bay. The principal localities are Fort Albany, Fort Simpson, Fort Resolution, Fort McPherson, Big Island, Fort Rae, Fort Good Hope, Hudson bay, Fort Anderson, Anderson river, Peel's river, Yukon river, Franklin bay, Plover bay, Fort Yukon, mouth of Porcupine river, Norton sound, St. Michaels, and Point Barrow. They were collected for the most part by E.W. Nelson, B. R. Ross, R. McFarlane, George McTavish, J. Reid, R. Kennicott, L. Clarke, Jr., J. Lockhart, C. L. McKay, and Lieut. P. L. Ray.

Putorius richardsoni cicognani (Bonaparte). The small brown Weasel.

Pl. I, figs. 4, 4*a*; II, figs. 4, 4*a*; III, figs. 2, 2*a*.

Mustela (*Putorius*) *vulgaris* Rich., Fauna Boreali-Am. Quad., p. 45, 1829.
Mustela cicognani Bonaparte, Fauna Italica, fasc. XXII, 1838, Charlesw. Mag., II, p. 37, Jan., 1838.
Putorius cicognani Rich., Zool. Beechey's Voyage, p. 10,* 1839.
  Baird, Mamm. N. Am., p. 161, 1857.
  Samuels, Rept. Agric. Mass., p. 154, plate I, fig. 6, 1861–1862.
  Gilpin, Trans. Nova Scotia Inst., II, p. 13, 1866 (read March, 1866).
Putorius richardsoni Gilpin, Trans. Nova Scotia Inst., p. 15, 1866 (read March, 1866).
Putorius vulgaris Emmons, Rept. Quad. Mass., p. 44, 1840.
  Thompson, Nat. Hist. Vermont, p. 30, 1842.
  Allen, Proc. Boston Soc. Nat. Hist., XIII, p. 183, 1869; Bull. Mus. Comp. Zoöl., I, p. 167, 1870.
  Merriam, Mammals Adirondacks, p. 54, 1882.
Mustela fusca Aud. and Bach., Journal Acad. Nat. Sci. Phila., VIII, pt. II, p. 288, 1842.
  DeKay, Zoöl. New York, I, p. 35, 1842.

Putorius fuscus Aud. and Bach., Quad. N. Am., III, p. 184, pl. 140, 1853.
Mustela pusilla DeKay, Zoöl. New York, I, p. 34, plate XIV, fig. I, 1842.
Putorius vulgaris var. *Americana* Gray, P. Z. S., p. 113, 1865; Cat. Carnivora British Mus., p. 91, 1869.
Putorius (*Gale*) *erminea* Coues, Fur-Bearing Animals, p. 109, 1877 (in part).

Type locality.—Eastern United States.

Geographic distribution.—Northeastern North America from Long Island and Connecticut north to Labrador and Newfoundland, west at least to Minnesota (Fort Snelling and Elk river), and probably following the transcontinental forest belt nearly, if not quite, across the continent; inhabits the whole of the Hudsonian, Canadian, and Transition zones.

P. richardsoni cicognani is the characteristic weasel of northeastern North America and the only one occupying a large area in the Canadian and Hudsonian zones. It extends south to the southern limit of the Transition zone, but no farther. It begins to overlap the range of *P. noveboracensis* in the lower Canadian zone, and thence southward gradually becomes rarer as *noveboracensis* becomes commoner, until it disappears altogether in the valley of the lower Hudson. I have never seen a specimen from any point farther south. All through Connecticut, Massachusetts, New York, New Hampshire, and Vermont both species occur together.

General characters.—Size small; tail short, a little more than one-fourth of the total length tipped with black; feet large and broad.

Color.—Summer pelage: Upper parts rich, dark brown, varying from Prout's brown to almost seal brown, examples in fresh pelage sometimes having the peculiar purplish tone of seal brown; ear often bordered by a narrow white margin (not a lingering of the white coat, as I have often seen it in the young that had never changed to the white winter dress), which in worn midsummer specimens usually disappears. Southern specimens are rather darker, as a rule, than northern ones. Under parts usually pure silvery white in the more southern examples, but sometimes tinged with greenish yellow in specimens from Newfoundland and Labrador. The line of demarkation between colors of upper and under parts is high up, straight, unbroken, and very distinct, owing to the great contrast in color. Occasionally a specimen can be found with one or more irregular spots of brown on the chest and belly. The color of the under parts covers the under sides of the arms and hands and the inside of the legs and the toes. Upper lips always white; tail same color as back, both above and below, with a short black tip, which, including the pencil, occupies about one-third of the tail; under fur about the same color as the long hair. Winter pelage: Pure white all over, with usually a strong yellowish tinge on the hindquarters, tail, and belly; end of tail for a little more than the pencil, jet black; coat long and full; feet heavily furred. The change to a white winter pelage takes place over the entire range of the subspecies. In Connecticut *P. richardsoni cicognani* always turns white in winter, while *P. noveboracensis* never does.

It is rather curious that in changing back to the brown summer coat in spring (the change taking place in March or April, according to locality) the white hairs persist longer in a well defined spot between the eyes and in front of the ears than elsewhere on the head. In the bridled weasel this spot between the eyes is a constant character, and in *P. peninsulæ* the white patch in front of the ears is a constant character; and still these weasels have no white winter coat.

Size.—Average of ten adult males from the lower Canadian and Transition zones: total length, 285; tail vertebræ, 77.5; hind foot, 37. Average of three adult females from the lower Canadian and Transition zones: total length, 254; tail vertebræ, 69; hind foot, 30.5.

P. cicognani varies somewhat in size all through its range, but apart from this individual variation there is a gradual increase from south to north, and specimens from Newfoundland and Labrador and also those from Lake Edward and Godbout, Quebec, are nearly equal in size to *richardsoni.* A specimen from Codroy, Newfoundland (No. 3751, male, old adult, coll. E. A. and O. Bangs), measures: total length, 339; tail vertebræ, 97; hind foot, 48.

Skull.—Skull smooth and light, not developing sagittal crest with age. It differs very little from the skull of *richardsoni*, but perhaps is a little narrower and deeper, with the inflated squamosal a trifle more inflated and larger, and usually quite flush with the audital bulla, from which it is separated by an almost straight line; mandible and teeth rather lighter.

Two skulls from Codroy, Newfoundland (Nos. 1164 and 1177, coll. E. A. and O. Bangs), present a very remarkable character that I have never seen in any other skulls of *Gale.* Each has an extra molar on each side of the upper jaw, placed behind the regular last upper molar. These teeth are small and round, but well shaped and symmetrical on the two sides.

Remarks.—Bonaparte first described this little weasel under the name *Mustela cicognani* (*Fauna Italica*, fasc. xxii, 1838), giving a very brief and imperfect account of it, and no definite type locality; but his description indicates this animal and can apply to no other. Furthermore, the following statement, made by him the same year in Charlesworth's Magazine of Natural History, leaves no doubt as to the animal he had. He said: "During my stay in the United States I only saw a small species of *Mustela*, very common throughout the Union, which all the naturalists at that time considered as the *M. vulgaris.* I at once perceived that it was not that European animal, and that it approached more to the *M. erminea.* From that remark of mine the name was changed, as, for example, in Dr. Godman's Natural History. I have since, in my Iconography of the Italian Fauna, speaking of the new *M. boccamela*, taken an opportunity of revising the group *Mustela*, and of distinguishing the American under the name of *M. cicognanii*, as it is intermediate between the two European species." *P. cicognani*, before Bonaparte separated it, was, as he states, generally confused with the European *P. vul-*

garis (= *P. nivalis*). Richardson's *P. vulgaris* from Carlton House, Saskatchewan (Fauna Boreali-Americana, I, p. 46), is clearly this species. It was an adult female and the measurements given were taken before skinning. Richardson himself positively states this on page 10* of the Zoölogy of Beechey's Voyage.*

Professor Baird, in 1857, gave a clear and accurate description of *P. cicognani* (Mammals of North America, 161–162), but unfortunately he was not followed by subsequent authors.

Although the extremes of *richardsoni* and *cicognani* are very different-looking weasels, the evidence seems to prove that they are only races of one species. The larger light-colored weasels from Newfoundland and Labrador may safely be considered as intermediate, though rather nearer *cicognani*, while the Fort Albany specimen, referred to under *richardsoni*, is an intermediate, rather nearer to *richardsoni*.

Putorius rixosus sp. nov. Least Weasel.

Pl. I, fig. 6; II, fig. 6; III, fig. 4.

Putorius pusillus Baird, Mamm. N. Am., p. 159, 1857 (not DeKay).
Putorius vulgaris Coues, Fur-Bearing Animals, p. 102, 1879 (in part).

Type from Osler, Saskatchewan, No. 642, female, young adult, coll. E. A. and O. Bangs, coll. by W. C. Colt, July 15, 1893. Original No., 79.

Geographic distribution.—Arctic and boreal America from Alaska south at least to Saskatchewan and Moose Factory.

General characters.—Size very small; tail very short, without black; pencil short.

Color.—Summer pelage: Upper parts rich reddish brown, from burnt umber to Vandyke brown; under parts pure white in every example but the type. The type has the under parts a soiled white or pale drabbish, that I attribute rather to staining than to coloring matter in the hair itself, as many of the hairs when taken singly are white; line of demarkation between colors of upper and under parts high up and even; color of under parts covering under side of arms and hands and inside of legs and toes; upper lips white; tail to very end same color as back; under fur same color as the long hairs. Winter pelage: Entirely pure white all over, including end of tail. The change to a white winter pelage probably takes place over the entire range of the species.

Size.—Type (female yg. ad.): Head and body, 150; tail, 31 (taken in flesh by collector, W. C. Colt).

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*In many worn midsummer specimens of *P. cicognani* the black tip to the tail fades to a blackish brown, and is then not in very marked contrast to the rest of the tail. Specimens in this condition may have strengthened the opinion, so generally held by early writers, that the animal was identical with the European *P. nivalis*.

Skull.—Skull very small and light, with the same oblong brain case and large inflated squamosal as in all the *richardsoni* group, from which it differs in exceedingly small size only.

Remarks.—This rare and little known weasel was first described by Baird in 1857. But Baird referred it to *Mustela pusilla* of DeKay, with the remark, "It is barely possible that the specimen here described may be different from the New York species as given by Dr. DeKay." De Kay's *M. pusilla* was the *M. cicognani* of Bonaparte, as shown by his description and measurements and by its geographical distribution.

P. rixosus is at present very imperfectly represented in collections. There are a few skins in the United States National Museum from points in Arctic America, from Fort Albany to Alaska. Most of these skins are in poor condition and have what is left of the skull inside the skin. They are also unsexed. There are two very good skins from Moose Factory, Ontario, made by C. Drexler (No. 5532, Museum Comparative Zoölogy, Cambridge, Mass., and No. 4231, United States National Museum. The latter is labeled male, but I think it is really a female). Two of the Alaska examples are in winter pelage and are pure white all over, including the end of the tail. One from the upper Yukon (No. 13904, collected by E. W. Nelson) is apparently a male. All the others are apparently females. Even this male, although unmeasured, is, so far as can be judged, smaller than full-grown females of the European *P. nivalis*.

In summer pelage *P. rixosus* can be distinguished from the European *P. nivalis* by its darker color, and at all seasons by its very much smaller size.

Dr. Coues, in his 'Fur-Bearing Animals,' speaks of larger examples with longer tails, the ends of which are dusky, and refers such specimens to this species (which he called *P. vulgaris*). In this he was in error, as was Professor Baird in considering No. 2319 from Steilacoom, Washington, to be this animal. I have seen many such, and in every case close examination has proved them to be the young of either *P. richardsoni* or *P. cicognani*, with the milk dentition plainly visible. The short, closely haired tails of young weasels of this group, with the end not distinctly black, owing to the hairs of the tail not being full grown, gives them a superficial resemblance to *P. rixosus*. But in all such cases the teeth at once tell the story. Two specimens in the National Museum, No. 5686, from Big Island, and No. 5691, from Fort Rae, are very good examples in point.

P. rixosus is, I believe, the smallest known carnivorous animal.

Table of Average Cranial Measurements of Putorius.

Name.	Locality.	Sex and age.	Number of specimens.	Basilar length from anterior lip of foramen magnum to front of premaxillary.	Occipito-nasal length.	Greatest zygomatic breadth.	Greatest mastoid breadth.	Breadth across post-orbital processes.	Distance from audital bulla to post-glenoid process.	Greatest length of lower jaw.
P. longicauda	Alberta, Sask., and N. Dak	♂ ad.	6	47.4	46.8	29.6	25.8	14.0	3.7	29.0
"	Alberta, Mont., and N. Dak	♀ ad.	6	42.8	42.4	25.7	22.9	12.0	3.9	25.4
P. l. spadix	Fort Snelling and Elk river, Minn.	♂ ad.	5	48.2	47.6	29.5	25.8	14.4	3.3	30.4
"	" " "	♀ ad	2	44.1	42.3	25.1	22.5	11.9	3.6	26.5
P frenatus	Brownsville, Texas	♂ ad.	6	50.5	49.3	30.2	25.8	14.3	4.0	31.2
P peninsulæ	Tarpon Springs, Fla	♀ ad.	1	45 8	46.2	26.8	24.2	14.4	3.0	29.4
P. noveboracensis	Liberty Hill, Conn	♂ ad.	10	45.4	45.6	26.5	22.4	14.2	4.4	27.8
"	" " "	♀ ad.	6	37.9	38.3	20.8	18.3	11.0	4.6	21.6
P. richardsoni	St. Michaels and Yukon, Alaska.	♂ ad.	6	43.2	43.7	26.3	22.8	13.9	5.0	25.4
"	" " "	♀ ad.	3	37.8	38.8	21.7	19.1	12.0	4.8	21.1
P. r. cicognani	Codroy, Newfoundland	♂ ad.	7	41.3	41.5	23.5	20.3	12.3	5.1	23.3
"	Bucksport, Maine	♂ ad.	5	39.0	39.9	21.6	19.4	11.3	5.2	21.7
"	Ossipee, N. H	♂ ad.	4	38.6	39.0	20.9	18.8	10 7	5.3	21.2
"	Liberty Hill, Conn	♂ ad.	1	37.2	37.2	19.8	18 2	9.8	5.0	20.0
"	Codroy, Newfoundland	♀ ad.	3	36.6	36.2	19.3	17.1	10 3	5.1	18.9
"	Mt. Forest, Ontario	♀ ad.	1	32.6	33.2	17 8	16.0	8.8	5.0	17.4
P. rixosus (type)	Osler, Sask	♀ ad.	1	....	27.2	14.2	13.4	7.0	3.8	14.0
P. ermineus	England	♂ ad.	1	46.0	46.6	28.0	24.0	14.0	5.2	28.4
"	"	♀ ad.	1	40.6	42 4	24 2	21.2	13.4	5 2	23 2
P. nivalis	"	♂ ad.	4	35.8	35.7	20.7	18.1	10 4	4.1	20.0
"	"	♀ ad.	3	31.5	31.7	16.9	15.3	9.0	4.4	17.3

Table of Average Measurements.

Name.	Locality.	Sex and age.	Total length.	Tail.	Hind foot.	No. of specimens in average.
Putorius longicauda	Wingard, Sask	♂ old ad.	466.0	173.0	50.0	1
" "	Osler, Sask	♂ ad.	440.5	158.0	....	2
" "	Wingard, Sask	♀ old ad.	417.0	162.0	48 0	1
" "	South Edmonton, Alberta	♀ yg. ad.	389.0	145 0	45.0	1
Putorius longicauda spadix	Fort Snelling, Minn. (type loc.)	♂ ad.	461.0	170.5	54.4	5
" " "	" " " "	♀ old ad.	375.0	123.0	42 5	1
Putorius brasiliensis frenatus	Brownsville, Texas	♂ ad.	496.4	220.0	47.1	7
" " "	" "	♀ ad.	416.0	172.0	36.6	3
Putorius peninsulæ	Tarpon Springs, Fla	♀ ad.	374.0	127.0	44.5	1
Putorius noveboracensis	Liberty Hill, Conn	♂ ad.	407.9	138.4	47.5	10
" "	" " "	♀ ad.	319.0	106.5	33.7	6
Putorius richardsoni	Fort Franklin, Great Bear lake	♂ ad.	*	102 0	....	1
" "	Fort Simpson, Mackenzie river	♂ ad.	†	107.5	43.0	1
Putorius richardsoni cicognani	Codroy, Newfoundland	♂ ad.	327.3	94.7	46.1	7
" " "	Bucksport, Maine	♂ ad.	298.9	82 1	39.2	5
" " "	Ossipee, N. H	♂ ad.	277.8	79.6	36.6	5
" " "	Liberty Hill, Conn	♂ ad.	261.0	60 0	34.0	1
" " "	Codroy, Newfoundland	♀ ad.	256 7	77.3	33.3	3
" " "	Mt. Forest, Ontario	♀ ad	258 5	74.0	31.5	1
Putorius rixosus (type)	Osler, Sask	♀ ad.	181.0	31.0	....	1
" "	Yukon, mouth of Porcupine river, Alaska.	♀ ad.	177.5	17.5	....	1
Putorius ermineus	England	♂ ad.	393.0	123.0	47.0	1
" "	"	♀ ad.	314.0	88.0	40.0	1
Putorius nivalis	Scotland	♂ ad.	257.5	52.0	31.0	2
" "	"	♀ ad.	237.0	49.0	26.0	1

* Head and body, 280.

† Head and body, 261.

EXPLANATION OF PLATES.

PLATES I AND II.

(Explanation of figures the same in both plates.)

Fig. 1. *Putorius longicauda* (Bonap.).

  1. ♂ ad. Wingard, Saskatchewan (No. 73183, U. S. Nat. Mus., Dept. Agric. coll.).
  1*a*. ♀ ad. Wingard, Saskatchewan (No. 75483, U. S. Nat. Mus., Dept. Agric. coll.).

2. *Putorius noveboracensis* Emmons.

  2. ♂ ad. Adirondacks, New York (No. 3843, Merriam coll.).
  2*a*. ♀ ad. Adirondacks, New York (No. 5598, Merriam coll.).

3. *Putorius richardsoni* (Bonap.).

  3. ♂ ad. St. Michaels, Alaska (No. 36243, U. S. Nat. Mus.).
  3*a*. ♀ ad. St. Michaels, Alaska (No. 36246, U. S. Nat. Mus.).

4. *Putorius richardsoni cicognani* (Bonap.).

  4. ♂. Bucksport, Maine (No. 4247, coll. E. A. and O. Bangs).
  4*a*. ♀. Mt. Forest, Ontario (No. 789, coll. E. A. and O. Bangs).

5. *Putorius peninsulæ* Rhoads.

  ♀ old. Tarpon Springs, Florida (No. 2379, coll. S. N. Rhoads).

6. *Putorius rixosus* nob.

  ♀ ad. (type). Osler, Saskatchewan (No. 642, coll. E. A. and O. Bangs).

PLATE III.

Fig. 1. *Putorius longicauda* (Bonap.).

  1. ♂ ad. Wingard, Sask. (No. 73183, U. S. Nat. Mus., Dept. Agric. coll.).
  1*a*. ♀ ad. Wingard, Sask. (No. 75483, U. S. Nat. Mus., Dept. Agric. coll.).

2. *Putorius richardsoni cicognani* (Bonap.).

  2. ♂. Bucksport, Maine (No. 4247, coll. E. A. and O. Bangs).
  2*a*. ♀. Mt. Forest, Ontario (No. 789, coll. E. A. and O. Bangs).

3. *Putorius noveboracensis* Emmons.

  3. ♂ ad. Adirondacks, New York (No. 3843, Merriam coll.).
  3*a*. ♀ ad. Adirondacks, New York (No. 5598, Merriam coll.).

4. *Putorius rixosus* nob.

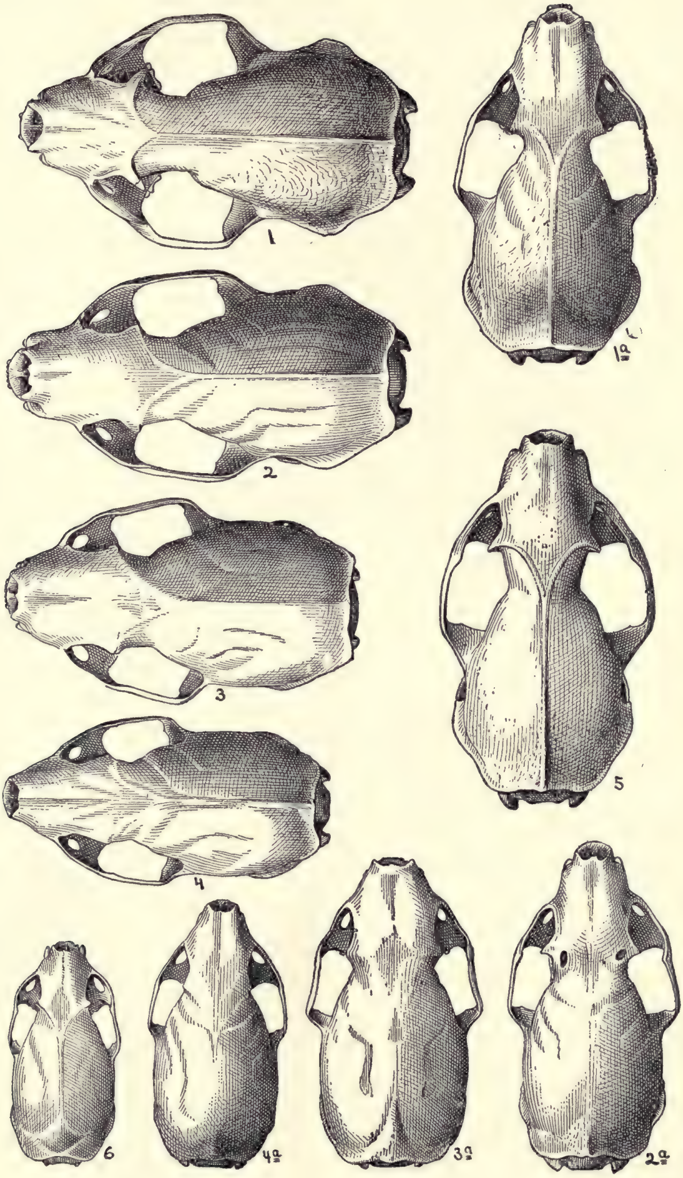
  ♀ ad. (type). Osler, Sask. (No. 642, coll. E. A. and O. Bangs).

5. *Putorius peninsulæ* Rhoads.

  ♀ old. Tarpon Springs, Florida (No. 2379, coll. S. N. Rhoads).

6. *Putorius richardsoni* (Bonap.).

  6. ♂. St. Michaels, Alaska (No. 36243, U. S. Nat. Mus.).
  6*a*. ♀. St. Michaels, Alaska, (No. 36246, U. S. Nat. Mus.).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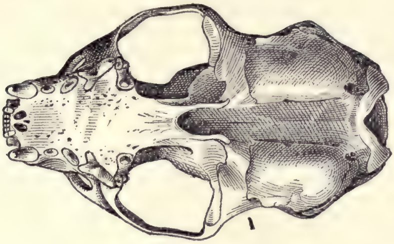
1. PUTORIUS LONGICAUDA 2. P. NOVEBORACENSIS 3. P. RICHARDSONI
4. P. CICOGNANI 5. P. PENINSULÆ 6. P. RIXOSUS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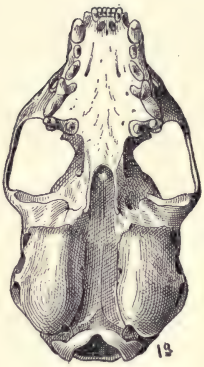
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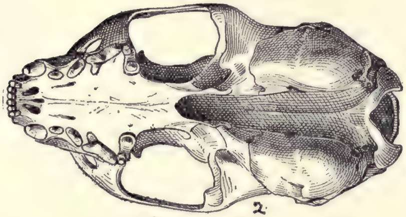
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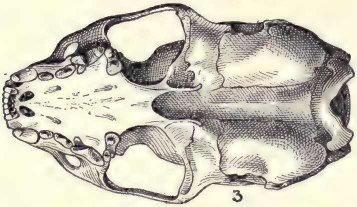
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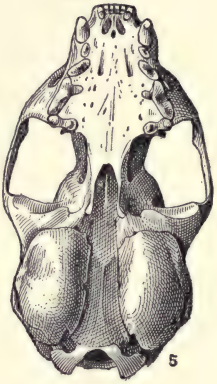
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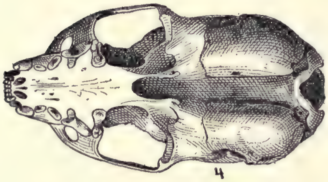
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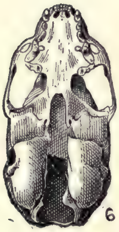
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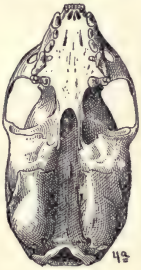
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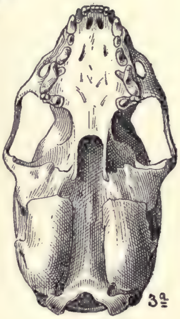
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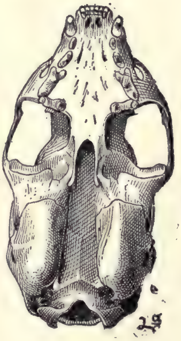
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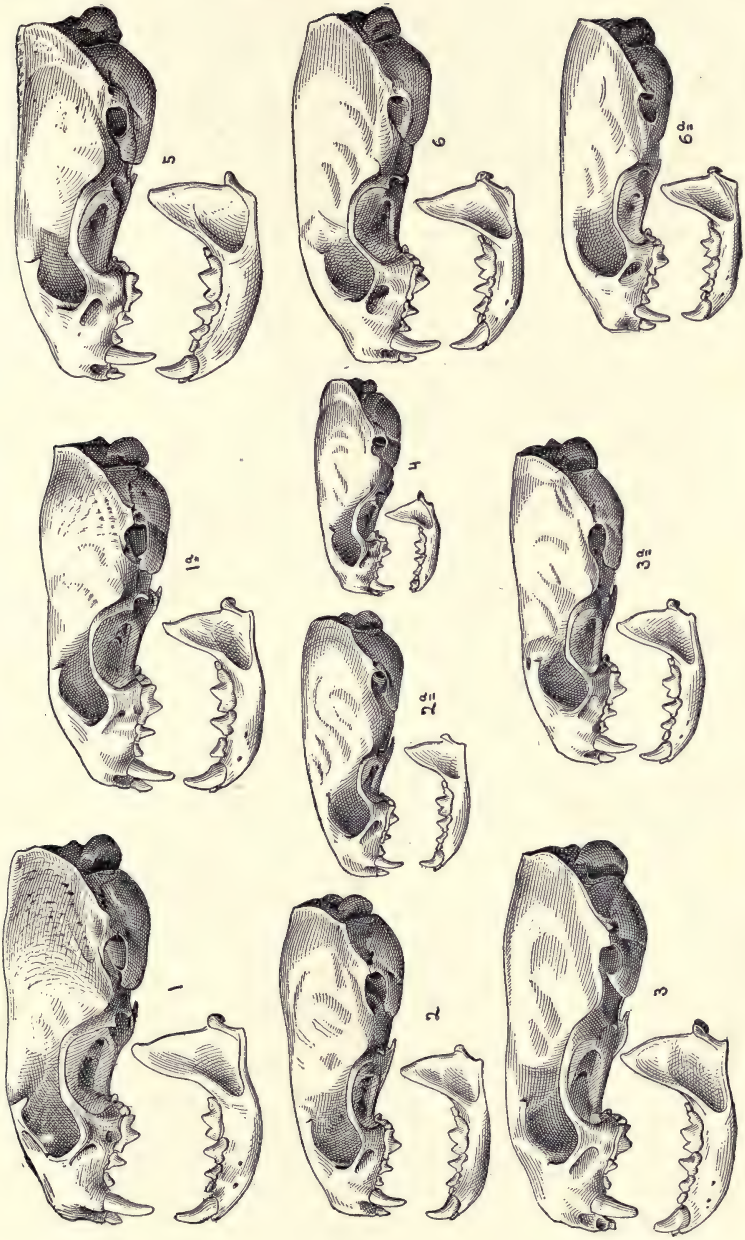
1. Putorius longicauda
2. P. noveboracensis
3. P. richardsoni
4. P. cicognani
5. P. peninsulæ
6. P. rixosus



1. PUTORIUS LONGICAUDA 2. P. CICOGNANI 3. P. NOVEBORACENSIS 4. P. RIXOSUS 5. P. PENINSULÆ 6. P. RICHARDSONI

VOL. X, PP. 25-28 FEBRUARY, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

THE FLORIDA DEER.

BY OUTRAM BANGS.

It has been known for many years that the Florida deer differed enormously in size from its more northern representative, and while most writers on the subject have mentioned this, no one has as yet separated the two. Until recently there has been a great lack of museum specimens of our larger mammals, and this fact alone can account for the Florida deer's remaining so long unnamed.

The Florida deer is little more than half the size of the deer of the northeastern United States, and, in addition to this, there are such other differences as decide me to give it full specific rank. The color of the Florida deer at all seasons is rather darker than that of *Cariacus americanus* (Erxleben),* and unlike the latter, it undergoes no decided change in pelage between winter and summer. The hair is about the same color, consistency, and length throughout the year, with only the change due to actual wearing and fading. Apart from size there are some very decided cranial and dental characters which separate the two species. The most striking of these is the shape and size of the nasal and maxillary bones and the very large molar and premolar teeth of the Florida animal.

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* The name *Cervus virginianus* Boddaert is so well known and has stood for our eastern deer so long that it seems like sacrilege to change it, but it is antedated by seven years by Erxelben's name *Cervus dama americana.* Erxleben proposed this name on page 312 of his Syst. Regni Animalis, Mammalia, 1777. In a separate paragraph at the end of his article on *Cervus dama* he asks if *americanus* is different, as supposed by Pennant (Differtne vere *americanus* vti Pennanto videtur?). He quotes a part of Pennant's description and gives synonymy, so that the name will have to stand. He gives its distribution as Virginia and Carolina.

Mr. Oldfield Thomas (in Ann. and Mag. of Nat. Hist. (6), xv, p. 193, Feb., 1895) points out that Gloger's generic name *Dorcelaphus* equals and antedates by one year Lesson's name *Cariacus,* but as *Dorcelaphus* is undoubtedly also antedated by other names, it seems wiser to keep the well-known name *Cariacus* until this point is definitely settled.

In the years 1893 and 1894 Mr. F. L. Small collected in Citrus county, Florida, five fine specimens of the Florida deer. These are now in the collection of E. A. and O. Bangs, and, with two superb deer lately sent me by Mr. Alvah G. Dorr from Bucksport, Maine, have served in defining the Florida species. Incidentally I have examined a large number of skulls and skins from various localities in the northeast. In comparing deer from Florida and Maine we have, of course, the extreme of differentiation in the east, but, as far as I have been able to ascertain, the deer of Virginia and Carolina does not differ essentially from that of Maine.

The Florida deer may be described as follows:

Cariacus osceola sp. nov.

Type No. 2394, coll. of E. A. and O. Bangs, female, young adult (2 to 3 years old) from Citronelle, Citrus county, Florida, coll. by F. L. Small, December 29, 1893. Original No. 1107.

General characters.—Size small; general color dark; hair short and fine at all seasons.

Color (of type specimen in fresh autumnal pelage).—Upper parts of back, neck, and head a mixed dark and light brown, each hair banded, dark brown at the tip, then yellowish brown, then dark brown and Isabella color at the base. The dark brown color predominates in a narrow median band along the back and is most intense on the neck and between the ears. On the flanks and along the sides the hairs are not banded, but are Isabella color at base and cinnamon at tips; sides and under surface of neck cinnamon; throat, belly, inside of legs, and arms white; ears sparsely haired; upper surface dark brown, many of the hairs tipped with yellow; inside surface white; the hairs of the upper side of tail are dark-red brown at base and cinnamon at tips; under side of the tail white, the hairs very long; eyelashes jet black.

An old male topotype (No. 2392, July 17, 1894), in worn midsummer coat, has lost the banding of the hairs and is a bright russet cinnamon above, which extends to the front of the eyes. The muzzle is very sparsely haired, and of a grizzled hair brown color, with a black spot behind each nostral. The tail is broadly edged with black at the base and black above at the tip.

An old male from Blitches Ferry, Citrus county, Florida (No. 2391, October 24, 1894) in fresh autumnal pelage is very dark above, the lower dark band of the hairs extending to their base and imparting to the whole upper parts a rich dark-brown color, variegated by the yellow bands of some of the hairs; tail not edged with black, but like that of the type.

A half-grown female topotype (No. 2395, August 9, 1894) has the hairs of the back unbanded and is clay color above, beautifully marked with small irregular white spots.

Size.—The only specimen measured in the flesh (No. 2391, male, old adult, from Blitches Ferry, Citrus county, Florida) afforded the following: Total length, 1,600; tail vertebræ, 280; hind foot, 500 (measured by the collector, F. L. Small).

The skull.—The skull of *Cariacus osceola* is very small; it is different in general shape from that of *C. americanus*, being much narrower and proportionally longer; the zygomatic arch lies much closer to the skull, and thus heightens its slender appearance; the nasal bones are long and slender, being about the length and about half the width of those of *C. americanus;* the whole rostral portion is slender. In *C. osceola* the nasal and premaxillary bones meet. In *C. americanus* the nasal and premaxillary are separated by a forward arm of the maxillary. (This arm of the maxillary varies somewhat in width, but is present in every skull of *C. americanus* I have examined, young and adult, while in every skull of *C. osceola*, both young and adult, that I have seen it is altogether absent.)

The teeth.—The molar and premolar teeth of *C. osceola* differ enormously in size from those of *C. americanus.* Every tooth is actually larger than the corresponding tooth in *americanus*, and the tooth row consequently longer.

The antlers.—The antlers of the male *C. osceola* apparently never attain a great size. No. 2391, which is a very old deer with four prongs, only measures 413 millimeters across the greatest stretch of his antlers, and the antlers themselves are small and light. *C. americanus* No. 4999, from Bucksport, Maine, is about the same age as No. 2391 and has also four prongs; they are much larger and heavier and measure across the greatest stretch 636 millimeters.

The Florida deer is of very general distribution over the whole of peninsular Florida, but in the more thickly settled and accessible parts of the State it has been much reduced in numbers of late. Its northern range is unknown to me, and I am therefore unable to state whether or not it overlaps the range of *C. americanus.*

Cranial Measurements of Cariacus americanus (Erxl.) *and Cariacus osceola* Bangs.

Number.	Sex and age.	Locality.	Basilar length (basion to front of premaxillary).	Occipito-nasal length.	Zygomatic breadth across middle of orbits.	Mastoid breadth.	Least interorbital breadth.	Greatest length of nasals.	Least breadth of nasals.	Length of upper tooth row on alveoli.	Greatest length of single half of mandible.	Length of lower tooth row on alveoli.
C. americanus.												
4999	♂ old ad.	Maine, Bucksport...........	296.0	259.5	136.0	109.0	82.0	96.0	26.0	79.5	240.5	82.0
5000	♀ old ad.	" "	259.0	231.0	121.5	90.0	72.0	90.0	24.0	66.5	221.0	73.5
C. osceola.												
2391	♂ old ad.	Florida, Blitches Ferry, Citrus county.	254.5	229.5	113.0	91.0	70.0	87.5	17.5	76.0	216.0	78.0
2392	♂ old ad.	Florida, Citronelle, Citrus county.	263.0	241.0	114.5	94.0	67.0	93.0	18.0	77.0	229.5	84.0
2394	♀ ad........	Florida, Citronelle, Citrus county.	220.0	202.0	91.0	70.5	51.5	83.0	14.0	73.0	194.5	80.0
2393	♀ ad........	Florida, Citronelle, Citrus county.	211.0	197.5	94.5	69.0	59.9	80.0	15.5	72.5	189.0	82.0

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

FOURTH LIST OF ADDITIONS TO THE FLORA OF WASHINGTON, D. C.

BY THEO. HOLM.*

The present paper is supplemental to Prof. Lester F. Ward's 'Guide to the Flora of Washington and Vicinity.'† It constitutes the fourth addition, and I have followed the same principles of nomenclature and arrangement as in the above-cited work of Professor Ward. I have also, in accordance with my previous addition,‡ not only enumerated such species as are new to the flora, and which are marked with an asterisk, but have also included a number of the rarer species recorded from new localities.

In spite of the fact that comparatively few of the Washington botanists are interested in the local flora, we have, nevertheless, succeeded in accumulating a very considerable amount of material for the study of the geographical distribution of plants within the limits of the flora. It is very interesting to see that several of the plants that have been recorded as new in the later additions are only new so far as concerns Professor Ward's flora. Several of them were already recorded by Brereton in his Prodromus,§ but not included in the list given by Professor Ward.

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* Presented at a meeting of the Biological Society of Washington, November 30, 1895.

† Bulletin No. 22, U. S. National Museum, 1881.

‡ Holm, Theo.: Proc. Biol. Soc., vol. vii, 1892, pp. 105–132.

§ Brereton, John A.: Floræ Columbianæ Prodromus. Washington, 1830.

These species belong almost exclusively to the fourth category, under which Professor Ward (l. c., p. 14) has designated a number of plants which he thought had either been exterminated or had accidentally disappeared since the publication of the Prodromus. Some of these plants are now known to be quite abundant in certain localities; for instance, *Apocynum androsæmifolium*, *Rhexia mariana*, *Polygala verticillata*, *Polygonum tenue* and *Cyperus flavescens.*

This fact seems to show that the flora of the District is yet but imperfectly known. There are, indeed, many and most interesting localities that have not yet been explored, and I will merely recall the fact that the southern and southeastern part of the District is still almost unknown. There is that interesting locality where Mr. G. W. Oliver obtained so many rare plants, which was recorded in the third addition as "the vicinity of Silver Hill."

This locality comprises the large forests, with creeks and sphagnum swamps, which lie between Silver Hill post-office and Surattsville, Prince George's county, Md. A visit to these forests shows us only too clearly that there is certainly a good deal of work to be done before we should venture to declare that we know our local flora. We meet here with species which are either not recorded in Professor Ward's flora or only enumerated as rare and of which several have been observed to occur in the greatest abundance, such as *Ilex glabra*, *Rhyncospora cephalantha*, *Agrostis elata*, *Uniola gracilis*, *Aristida purpurascens*, *Xyris flexuosa*, etc. The same is the case with several other places which have only been lately explored. Brookland, for instance, is the home of twenty species of *Panicum*, several of which have never been noticed before, although they are very common; there grow, also, *Apocynum androsæmifolium*, *Sporobolus vaginæflorus and Agrostis elata* quite abundantly.

But, besides these truly indigenous species, I have also noted some others, which have been accidentally introduced—*e. g.*, *Tribulus maximus* * and *Leptochloa mucronata*,† both of which appeared suddenly in the Agricultural grounds. *Leptochloa* was very abundant, with ripe seeds, and it may, therefore, also spread to other parts of the city and become a well-established citizen.

Among the species enumerated in the following list are several which Professor Ward had considered so common that no special locality was recorded. Extended researches have, however, induced me to arrange some of these among the rarer plants, and I thought, also, that in this way a better idea of their distribution might be obtained.

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* Found by G. H. Hicks.

† Found by the author.

3. **Clematis Virginiana** L.

Along the Canal road near the Eighth lock. G. H. Hicks.

10. **Anemone nemorosa** L.

Banks, Four-Mile Run. R. R. Gurley.

13. **Ranunculus pusillus** Poir.

A very large specimen was collected in a stagnant pool by Piney Branch, at the north end of Seventeenth street. G. H. Hicks.

26. **Aconitum uncinatum** L.

Near Chevy Chase. G. H. Hicks.

40. **Papaver dubium** L.

Bank of Potomac above Rosslyn, Va., near the Seventh lock along the Canal road. G. H. Hicks.

45. **Fumaria officinalis** L.

Along Bates road near Bunker Hill. The author.

47. **Nasturtium sylvestre** R. Br.

Potomac flats near the Seventh lock. G. H. Hicks.

51. **Nasturtium Armoracia** Fries.

Along a ditch near Terra Cotta, escaped. The author.

55. **Arabis dentata** T. & G.

Along the Canal road near the Seventh lock. G. H. Hicks.

61. **Cardamine hirsuta** L. (*C. intermedia* Horn.)

Rock Creek. G. H. Hicks. The Zoölogical Park; in full bloom the 10th of May, 1895. The author.

* **62***a*. **Cardamine parviflora** L.

Shaded woods in Brookland; in moist, rich soil near Terra Cotta. The author.

* **62***b*. **Cardamine silvatica** Link.

Terra Cotta swamp; Rock Creek. The author.

* **62***c*. **Cardamine Pennsylvanica** Muhl.

Meadow near Rosslyn. T. H. Kearney, Jr. Rock Creek near the Zoölogical Park; in creeks on the Virginia shore of the Potomac, one mile above Aqueduct Bridge. In flower the second week of May. The author.

It seems, according to the Synoptical Flora of North America,* that these species of *Cardamine* are not well understood in this country. The difficulty in distinguishing them is evidently due to insufficient European material for comparison. The name *Cardamine hirsuta* L. is very misleading, and I have therefore added as a synonym *C. intermedia* Horn. This name is used by Professor Lange,* since Linnæus undoubtedly included Link's *sylvatica* under his *hirsuta*, until Hornemann separated them, naming the last of these '*intermedia*.' † They are very different from each other, and we add the following characters as supplemental to those already given in the Synoptical Flora (l. c.):

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* Vol. I, part I. Continued and edited by B. L. Robinson, 1895, page 158.

Cardamine hirsuta L. (*C. intermedia* Horn).

Basal leaves very numerous and persisting for a long time, large and forming a dense rosette; they are most often smooth; the terminal leaflet is larger than the lateral ones, orbicular or reniform. Flowering stems, several, simple or with a few branches, ascending from a decumbent base. The uppermost pods surmount the flowering part of the raceme.

This species is said to be "abundant about Washington, D. C.," which is evidently a mistake. It might have been confounded with *C. sylvatica* Link.

Cardamine parviflora L.

The basal leaves are few in number and early fading; the plant is strictly annual; otherwise the description in the Synoptical Flora (l. c.) corresponds very well to this species.

Cardamine silvatica Link.

This species is not mentioned in the Synoptical Flora. The basal leaves are few, early fading; those of the stem numerous, with large and broad divisions, the margin dentate. The pods are borne on more or less horizontal pedicels, and the uppermost ones are hardly surpassing the flowering part of the raceme. The plant is most often biennial in the vicinity of Washington, but occurs also as a perennial in Europe.

63. Dentaria heterophylla Nutt.

The Zoölogical Park. The author.

***63*a*. Dentaria cardiophylla** Robinson.

Described in the Synoptical Flora (l. c., p. 155).

Collected in Rock Creek by George R. Vasey.

72. Camelina sativa (L.) Crantz.

Near Rosslyn, Va. T. H. Kearney, Jr.

*** 77*a*. Lepidium Draba.**

Lincoln Park. A. G. Maesius.

80. Helianthemum Canadense Michx.

Sand hills near Terra Cotta. The author.

82. Viola lanceolata L.

Bladensburg. M. B. Waite.

90. Viola striata Ait.

Near Glen Echo, along the Canal road. G. H. Hicks. On the Virginia shore of the Potomac, two miles above Aqueduct Bridge. The author.

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* Lange, Joh. Haandbog i den Danske Flora. Kjöbenhavn, 1886–'88, page 629.

† Hornemann, I. W. Oekonomisk Plantelære, 1821–'39, page 714.

94. **Viola tricolor** L., var. **arvensis** Ging, is **V. tenella** Muhl.

96. **Polygala incarnata** L.

Near Chevy Chase; Takoma. G. H. Hicks. In pine woods in several places around Brookland. The author.

99*a*. **Polygala Curtissii** Gr., var. **pycnostachya** Gr.

Near Carlins, Va.; Takoma. G. H. Hicks. Terra Cotta swamp; near Surattsville, Prince George County. G. W. Oliver and the author.

100. **Polygala ambigua** Nutt.

In a dry field along the Walker road near Surattsville. The author.

101. **Polygala verticillata** L.

Bunker Hill; Brookland. The author. Near Chevy Chase. G H. Hicks.

* 104*a*. **Saponaria Vaccaria** L.

Along the railroad track near University Station; in bloom third week of May, 1894. The author.

106. **Silene nivea** D. C.

Bank of Potomac, two miles above Aqueduct Bridge, Va. G. H. Hicks.

108. **Silene Armeria** L.

Among wheat near Garrett Park. The author.

122. **Anychia dichotoma** Michx.

Open places in the pine woods around Brookland. The author.

145. **Linum striatum** Walt.

Very abundant in Terra Cotta swamp, near the railway track. The author.

149. **Geranium columbinum** L.

Hillside near Aqueduct Bridge, on the Virginia shore. The author.

158*a*. **Ilex glabra** (L.) Gr.

Abundant in woods along the Walker road between Camp Spring P. O. and Surattsville. G. W. Oliver, W. T. Swingle, and M. B. Waite.

161. **Ilex lævigata** Gr.

With the preceding.

174. **Acer saccharinum** Wang.

This species has spread from the city parks to the woods between Eckington and the Catholic University. The author.

194*a*. **Trifolium medium** L.

Reported by Mr. G. B. Sudworth and published in the Third Addition to the Flora of the District; not this species, but merely a form of *T. pratense* L.

216. **Desmodium ciliare** D. C.

Common in open pine woods, Brookland. The author.

217. **Desmodium Marilandicum** Boott.

Very scarce in dry fields, Brookland. The author.

230. **Clitoria Mariana** L.

Near Carlins, Va., near Fort Reynolds, Va. G. H. Hicks.

234. Phaseolus perennis Walt.

Near Carlins, Va., and near Fort Reynolds. G. H. Hicks.

250. Spiræa Aruncus L.

Very common near Garrett Park. The author.

256. Rubus hispidus L.

Exceedingly abundant in the swamps near Surattsville. W. T. Swingle, M. B. Waite and the author.

259. Rubus cuneifolius Pursh.

Dry hillside near Silver Hill P. O. The author.

270. Poterium Canadense B. & H.

Terra Cotta swamp. The author.

272. Rosa setigera Michx.

Along Rock Creek below Pierce's Mill. G. H. Hicks.

278. Pirus coronaria L.

South Brookland. Robert Ridgway.

295*a*. Ribes floridum l'Her.

Near the Baptist Church in Brookland, 1895. Now destroyed. The author.

300. Drosera rotundifolia L.

Common in swamps between Camp Spring P. O. and Surattsville. G. W. Oliver and the author.

304. Proserpinaca palustris L.

Not common. One mile above Glen Echo. T. H. Kearney, Jr.

304*a*. Callitriche Austini Eng.

Several places in the woods around Brookland. The author. It is evidently not rare, but overlooked. It grows in deep shade on black, rich soil.

305. Callitriche verna L.

Pool near Piney Branch, at the north end of Seventeenth street. G. H. Hicks.

316*a*. Oenothera pumila L.

Near Surattsville. W. T. Swingle and M. B. Waite.

317. Oenothera sinuata L.

A single specimen was collected in a dry field, South Brookland. The author.

327. Hydrocotyle ranunculoides L.

Under Bennings bridge. The author. Above Rosslyn. G. H. Hicks.

339. Chaerophyllum procumbens Crantz.

Not common, and has only been observed along the Potomac shore, on both sides of the river, but especially on the Virginia side. It has been collected on the Maryland side along the Canal, near the Seventh lock, by G. H. Hicks.

345. Pastinaca sativa L.

Clover field in South Brookland; along the electric car track near Eckington. The author.

* **348***a*. **Caucalis Anthriscus** Huds.

A single specimen near Bathing Beach, back of the Monument grounds; July 5, 1894. G. H. Hicks.

351. Aralia nudicaulis L.

High Island. T. H. Kearney, Jr. Blagden's Run. G. H. Hicks.

384. Fedia olitoria Vahl.

Island of the Potomac, near the Seventh lock. G. H. Hicks. South Brookland. The author.

The specimens which Mr. Hicks has collected were rather robust for the typical species. The corolla was, however, light blue. Therefore I have not hesitated in recording them under this species.

390*b*. **Eupatorium semiserratum** D. C.

Great Falls. The author.

391. Eupatorium hyssopifolium L.

Woods near Glen Echo. G. H. Hicks. Brookland. The author.

391*a*. **Eupatorium altissimum** L.

Island in Potomac, near the Seventh lock. G. H. Hicks.

400. Eupatorium aromaticum L.

Rock Creek. G. H. Hicks.

402. Mikania scandens L.

Swamp between Eckington and the Catholic University. Robert Ridgway.

426. Sericocarpus solidagineus Nees.

Rather rare. Dry field, Surattsville. The author.

430. Aster concolor L.

Surattsville. The author.

494*a*. **Bidens connata** Muhl., var. **comosa** Gray.

Bank of Potomac, opposite mouth of Cabin John's Run, Md. G. H. Hicks. Ditch near Metropolis View; along a creek near the Catholic University. The author.

497*a*. **Galinsoga parviflora** Cav.

Near Bureau of Engraving and Printing. G. H. Hicks. Massachusetts avenue, between Fourteenth and Fifteenth streets. The author.

504*a*. **Senecio vulgaris** L.

Potomac flats near Bureau of Engraving and Printing. G. H. Hicks.

536. Tragopogon porrifolius L.

Near Eckington, escaped. The author.

539. Lobelia puberula Michx.

Rock Creek. G. H. Hicks. Swamp near Silver Hill. The author.

542. Specularia perfoliata A. DC.

A form without corolla is common in shaded woods around Brookland. The author.

543. Campanula Americana L.

Island of the Potomac, opposite the Eighth lock. G. H. Hicks.

543*a*. **Campanula aparinoides** L.

Terra Cotta swamp; quite abundant among *Lilium superbum.* The author.

551. **Gaultheria procumbens** L.

Burnt Mills; near Surattsville. M. B. Waite.

564. **Pyrola secunda** L.

Garrett Park. P. H. Dorsett.

565. **Pyrola chlorantha** Swtz.

Garrett Park. P. H. Dorsett.

566. **Pyrola elliptica** Nutt.

Garrett Park. The author.

567. **Pyrola rotundifolia** L.

Near Chevy Chase. G. H. Hicks.

569. **Monotropa Hypopitys** L.

The typical form is not rare in the District and seems to correspond exactly to the European plant. But a very peculiar form has also been collected, which differs from the description given of *M. Hypopitys* so much that it seems to represent a distinct species. It is, for instance, of a red, almost blood-red, color and densely pubescent all over. I have secured some material of the European plant, preserved in alcohol, and it is my intention to give a detailed account of the characters, morphological and anatomical, so as to decide whether we shall consider this plant to represent a species or only a variety. It has been collected in Rock Creek by G. H. Hicks and near Arundel (Anne Arundel County, Md.), by M. B. Waite.

570. **Dodecatheon Meadia** L.

Near Cabin John's Bridge. A. J. Pieters.

585*a*. **Apocynum androsæmifolium** L.

Very common in low grounds in South Brookland. The author.

589. **Asclepias rubra** L.

Sphagnum swamp near Surattsville. J. Krause and the author.

594. **Asclepias obtusifolia** Michx.

Not common. Brookland. The author.

595. **Asclepias variegata** L.

The Zoölogical Park; Blagden's mill-race. G. H. Hicks. Brookland. The author.

597. **Asclepias verticillata** L.

In pine woods at Brookland. The author.

605. **Gentiana ochroleuca** Froel.

Blagden's Run; Glen Echo. G. H. Hicks. Brookland. The author.

608. **Phlox paniculata** L.

Near Glen Echo. G. H. Hicks.

615*a*. **Phacelia Covillei** Wats.

Island near the Seventh lock. G. H. Hicks. Very abundant on High Island. M. B. Waite.

617. Phacelia parviflora Pursh.

About two miles above Aqueduct Bridge, on the Virginia shore of the Potomac. The author. Along the Canal road near the Seventh lock. G. H. Hicks.

623. Myosotis laxa Lehm.

In a pool near the north end of Seventeenth street and Piney Branch. G. H. Hicks.

634. Ipomæa lacunosa L.

The Canal road near the Seventh lock. G. H. Hicks.

635. Convolvulus spithamæus L.

Very abundant in open thickets in North and South Brookland. The author. Ivy City. T. H. Kearney, Jr.

637. Convolvulus arvensis L.

Along the electric car track between Eckington and the Catholic University. The author.

643. Physalis pubescens L.

Bank of the Potomac back of the Twelfth lock. G. H. Hicks.

643*a*. Physalis Philadelphica Lam.

Bank of Potomac opposite mouth of Cabin John's Run. G. H. Hicks.

657. Pentstemon lævigatus Soland.

Common in South Brookland. The author.

660. Herpestis nigrescens Bth.

Great Falls (Virginia side). M. B. Waite.

666. Veronica Americana Schwein.

Potomac Boat Club landing, Virginia. G. H. Hicks.

669. Veronica serpyllifolia L.

Woodley Park. The author.

671*a*. Veronica hederifolia L.

The Virginia shore of the Potomac, two miles above Aqueduct Bridge. The author.

680. Melampyrum Americanum Michx.

Takoma Park. G. H. Hicks.

681. Orobanche minor L.

Magnolia Run. G. H. Hicks.

682. Aphyllon uniflorum Gr.

North Brookland. The author.

686. Utricularia gibba L.

Opposite the Eleventh lock, Maryland. G. H. Hicks.

724. Monarda punctata L.

Not common. Rock Creek near Brightwood. G. H. Hicks. North Brookland. The author.

725. Lophanthus nepetoides Bth.

Bank of the Potomac near the Twelfth lock, Maryland. G. H. Hicks.

732*a*. Scutellaria parvula Michx.

On dry, sandy soil, North and South Brookland. The author.

745. Plantago Patagonica Jacq. var. **aristata** Gr.

East Brookland; around Allentown, Prince George County, Md. The author. Near Fifteenth and W streets. G. H. Hicks. Near Chevy Chase. M. B. Waite.

747. Amarantus paniculatus L.

Near Pierce's mill. G. H. Hicks. Around Silver Hill, Prince George County. The author.

749. Amarantus albus L.

Near Bureau of Engraving and Printing. G. H. Hicks.

***769*a*. Polygonum Muhlenbergii** Watson.

Potomac flats, opposite the Eighth lock, Maryland. G. H. Hicks.

773*a*. Polygonum tenue Michx.

Abundant in dry fields, Brookland; sandy soil near Terra Cotta. J. Krause and the author.

780. Rumex Britannicus L.

Potomac flats near Rosslyn, Va. G. H. Hicks.

781. Rumex verticillatus L.

With the preceding. G. H. Hicks.

800. Euphorbia commutata Engelm.

Glen Echo. T. H. Kearney, Jr. and G. H. Hicks.

843. Quercus ilicifolia Wang.

Abundant near Laytonsville and Goshen, Montgomery County, Md. George B. Sudworth.

901. Habenaria tridentata Hook.

Near Chevy Chase. G. H. Hicks. North Brookland. The author.

904. Habenaria lacera R. Br.

Terra Cotta swamp. The author. Swamp near Surattsville. J. Krause and the author.

911. Pogonia ophioglossoides Nutt.

Sphagnum swamp near Surattsville. W. T. Swingle and M. B. Waite.

912. Pogonia verticillata Nutt.

North Brookland; near Terra Cotta. The author.

922. Cypripedium pubescens Willd.

Blagden's Mill, Rock Creek. R. R. Gurley. Burnt Mills. M. B. Waite. South Brookland. The author.

925. Aletris farinosa L.

Very common around Surattsville. The author. Near Arundel, Md. M. B. Waite.

955. Trillium sessile L.

Island near the Seventh lock. G. H. Hicks.

957. Veratrum viride Ait.

Magnolia Run. L. H. Dewey. Garrett Park. The author.

***962*a*. Muscari racemosa** Nutt.

Island near the Seventh lock. G. H. Hicks.

982. Commelina hirtella Vahl (*C. erecta* L)
Bennings Bridge. The author.

***982*a*. Commelina communis** L.
Magnolia Run, Rock Creek Park. G. H. Hicks.

983. Commelina Virginica L.
Flats of the Potomac under Chain Bridge. The author.

985. Xyris flexuosa Muhl.
Along the railroad track near Carlins, Va. G. H. Hicks. Sphagnum swamps in the woods near Surattsville. The author.

988*a*. Cyperus aristatus Rottb. (*C. inflexus* Muhl.).
Muddy bottom of Potomac, opposite mouth of Cabin John Run, Md. G. H. Hicks.

998. Cyperus retrofractus Torr.
South Brookland. The author.

***999*a*. Kyllinga pumila** Michx.
Holmead swamp. M. B. Waite.

***1000*a*. Hemicarpha subsquarrosa** Nees.
Potomac flats opposite the Ninth lock, Md. G. H. Hicks.

***1004*a*. Eleocharis intermedia** Schult.
Opposite the Eighth lock, Md. G. H. Hicks.

1007. Scirpus planifolius Muhl.
On dry, grassy slopes in the Zoölogical Park. The author.

1010. Scirpus debilis Pursh.
Potomac flats opposite the Ninth lock, Md. G. H. Hicks. Sphagnum swamp near Silver Hill. The author.

1017. Eriophorum Virginicum L.
Sphagnum swamp near Surattsville. The author.

1019, Fimbristylis capillaris Gr.
Along the railroad track near Carlins, Va. G. H. Hicks. North Brookland. A. J. Pieters.

1020. Rhyncospora alba Vahl.
Sphagnum swamp near Surattsville. The author.

1021*a*. Rhyncospora cephalantha Gr.
Common in swamps around Surattsville and Silver Hill. The author.

1024. Scleria pauciflora Muhl.
Grassy knoll near Aqueduct Bridge on the Virginia shore of the Potomac. The author.

1025. Carex polytrichoides Muhl.*
Magnolia Run, Rock Creek Park; Sphagnum swamp near Surattsville. The author.

1026. Carex Willdenovii Schk.
Bunker Hill; Corcoran's woods. The author.

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* Professor Charles F. Wheeler has kindly revised the entire collection of the genus *Carex* recorded here.

1030a*. **Carex conjuncta** Boott.

High Island. The author.

1030b*. **Carex alopecoidea** Tuckerm.

Low meadow near the Insane Asylum. The author.

1031. Carex stipata Muhl.

Rock Creek woods. G. H. Hicks. Near Surattsville. The author.

1035a*. **Carex Muhlenbergii** Schk., var. **enervis** Boott.

High Island and along the Canal road; not rare. G. H. Hicks and the author. Bunker Hill. The author.

1040. Carex lagopodioides Schk.

The name should be changed to *C. tribuloides* Wahlbg.

1040a*. **Carex tribuloides** Wahlbg., var. **reducta** Bailey.

Common in shady places around Brookland; Insane Asylum. The author.

1047. Carex torta Boott.

Cabin John Run. G. H. Hicks.

1051. Carex Shortiana Dew.

High Island, near the river shore. The author.

1055. Carex glaucodea Port.

Bunker Hill. Open woods in North Brookland. The author. Along the towpath, C. and O. Canal, near Georgetown. T. H. Kearney, Jr.

1056. Carex pallescens L.

Grassy knoll near Aqueduct Bridge, on the Virginia shore of the Potomac. The author.

1063. Carex platyphylla Carey.

Shaded places on the rocks near Aqueduct Bridge, on the Virginia shore of the Potomac. The author.

1065. Carex retrocurva Dew.

On the rocks near Aqueduct Bridge, on the Virginia shore of the Potomac. The author.

1067. Carex laxiflora Lam.

The type seems to be rare; near the Insane Asylum. Lester F. Ward. Brookland. The author.

1072a*. **Carex laxiflora** Lam., var. **divaricata** Bailey.

Near Washington, D. C. George Vasey. Rock Creek. G. H. Hicks.

1072*b*. **Carex laxiflora** Lam., var. **patulifolia** Carey.

Common in the woods around Brookland. The author.

1074. Carex oligocarpa Schk.

Rare. On shaded rocks on the Virginia side of the Potomac near Aqueduct Bridge. The author.

1075. Carex umbellata Schk.

Bunker Hill; sandy hills around Terra Cotta. The author.

1076. Carex Emmonsii Dew.

In Professor Ward's catalogue is *C. varia* Muhl.

1078a*. **Carex communis** Bailey.

This species has undoubtedly been observed before in the District, but confounded with *C. Pennsylvanica* Lam. It is closely related to this last, from which it differs, however, by its cespitose growth without stolons. The scales of the staminate and fertile inflorescences are usually purplish, but lighter than those of *C. Pennsylvanica.* It is very common on the rocks of the Potomac shore, Virginia. The author.

1078b*. **Carex communis** Bailey, var. **Wheeleri** Bailey.

With the preceding. The author.

1080. **Carex pubescens** Muhl.

Cabin John Run; the Zoölogical Park. The author.

1081. **Carex prasina** Vahl. (*C. miliacea* Muhl.).

Woodley Park; the Potomac shore, three miles above Aqueduct Bridge, Va. The author.

1090. **Carex lupulina** Muhl.

Near Rosslyn, Va.; Potomac flats. G. H. Hicks. The Zoölogical Park. William Hunter.

1091. **Carex folliculata** L.

Takoma. T. H. Kearney, Jr. Magnolia Run, Rock Creek Park; abundant in the woods along Walker road, between Camp Spring P. O. and Surattsville. The author.

1092. **Carex squarrosa** L.

Near Chevy Chase circle. G. H. Hicks. Garrett Park. The author.

1093. **Carex stenolepis** Torr.

Common in South Brookland. The author.

1101. **Sporobolus asper** Beauv.

High Island. L. H. Dewey.

1101*a*. **Sporobolus vaginæflorus** Torr.

Common in low grounds, Brookland; the lawns in the Smithsonian Park, and around the Catholic University. The author.

1104a*. **Agrostis elata** Trin.

Common in pine woods, Brookland; also in the deciduous forests along Walker road, near Silver Hill, Surattsville, etc. The author.

1107. **Muhlenbergia sobolifera** Trin.

Woods in North Brookland, but very scarce. The author.

1114. **Calamagrostis Nuttalliana** Steud.

Takoma. F. L. Scribner, T. H. Kearney, Jr., and L. H. Dewey.

1119. **Aristida purpurascens** Poir.

Along the roads; very common near Allentown and Surattsville.

1125*a*. **Eatonia obtusata** Gr.

Dry fields, North Brookland. The author.

1126a*. **Eatonia Dudleyi** Vasey.

Brookland. Terra Cotta. The author. Rock Creek. L. H. Dewey.

This species is recorded in Professor Ward's Flora of the District as a slender wood form of *E. Pennsylvanica* Gr.

*1126*b*. A hybrid between **Eatonia Pennsylvanica** Gr. and **Trisetum palustre** L.

Has been described by Dr. George Vasey,* who found several specimens of this peculiar form in a low meadow on the banks of Hunting Creek, near where it empties into the Potomac River, a mile below Alexandria, Va.

1136. **Poa sylvestris** Gr.

High Island; on the Virginia shore of the Potomac near Aqueduct Bridge. The author.

1137. **Poa flexuosa** Muhl.

The Zoölogical Park. The author.

1143. **Eragrostis Purshii** Schrad.

Abundant along the railroad track between University Station and Terra Cotta. The author.

1153*a*. **Bromus tectorum** L.

Near the Navy Yard. The author.

1158. **Uniola gracilis** Michx.

Rock Creek. G. H. Hicks. Several places in the woods between Silver Hill and Surattsville. The author.

1172. **Phalaris Canariensis** L.

Waste grounds south of the Bureau of Engraving. G. H. Hicks.

1172*a*. **Phalaris arundinacea** L.

Ditch near Bates Road. The author.

1179. **Panicum proliferum** Lam.

Very common along the streets in Brookland. The author.

*1180*a*. **Panicum capillare** L., var. **minima** Engelm.

Common on dry, sandy soil in Brookland; near Silver Hill. The author.

*1183*a*. **Panicum commutatum** Schultes.

Extension of Kenesaw Avenue, Rock Creek. G. H. Hicks. Takoma; Four Mile Run. T. H. Kearney, Jr. Common in Brookland; near Surattsville; Terra Cotta. The author.

1185. **Panicum microcarpon** Muhl.

Takoma. T. H. Kearney, Jr. Brookland. The author.

1186. **Panicum viscidum** Ell.

Brookland; Terra Cotta swamp near the railroad track. The author.

1187. **Panicum scoparium** Lam.

Great Falls. F. L. Scribner.

1187*a*. **Panicum sphærocarpon** Ell.

Bunker Hill; North Brookland. The author. Takoma. T. H. Kearney, Jr.

*1188*a*. **Panicum ramulosum** Michx.

Sphagnum swamp near Takoma. F. L. Scribner and T. H. Kearney, Jr.

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* Botanical Gazette, vol. ix, 1884, p. 165.

1188*b*. **Panicum nitidum** Lam.

North Brookland; Bunker Hill. The author.

* 1188*c*. **Panicum lanuginosum** Ell.

Brookland; Garrett Park. The author.

* 1188*d*. **Panicum pubescens** Lam.

Brookland. The author.

1197. **Tripsacum dactyloides** L.

Near Silver Hill. The author.

1198. **Erianthus alopecuroides** Ell.

Takoma. F. L. Scribner. Field between Jackson City and Arlington, Va. G. H. Hicks.

1219. **Woodwardia angustifolia** Smith.

Very abundant in the woods near Surattsville. The author.

1229. **Aspidium cristatum** Swtz.

Numerous fruit-bearing specimens were observed near Chevy Chase. G. H. Hicks.

1236. **Cystopteris fragilis** Bernh.

Flats under Chain Bridge. The author.

1240. **Lygodium palmatum** Swtz.

Near Arundel, Md. M. B. Waite.

1245. **Botrychium ternatum** Swtz., var. **dissecta** Milde.

Near Chevy Chase circle. G. H. Hicks. Along Bates road near Terra Cotta swamp. The author.

1247. **Ophioglossum vulgatum** L.

In the woods near Garrett Park. M. B. Waite.

1252. **Selaginella rupestris** Spring.

Rediscovered near Great Falls by M. B. Waite.

1253. **Selaginella apus** Spring.

Swamp near Silver Hill. The author.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON.

ON A SMALL COLLECTION OF MAMMALS FROM LAKE EDWARD, QUEBEC.

BY OUTRAM BANGS.

Early in September, 1895, my brother, E. A. Bangs, and I made a short collecting trip to Quebec. Our original plan was to spend all our time at Roberval, on Lake St. John, the most northern locality reached by railroad in eastern North America. But Lake St. John proved a great disappointment. The town of Roberval lies in a dreary valley, that seems wholly destitute of mammalian life. The forest has been cleared away and the barren fields and desolate scrub are wholly unfit to supply the needs of even the smaller mammals. Had we been fitted for camping out we could undoubtedly have found a rich field up one of the many rivers that pour their waters from every direction into this great basin; but we were not. After wasting two days in a vain endeavor to find any place within walking distance of Roberval suited to our work, we turned our backs on Lake St. John and went down the railroad about sixty-five miles to Lake Edward.

The town of Lake Edward is on the northern end of the lake of the same name, and lies in the heart of a rich Hudsonian forest. The lake is about twenty-three miles long and terminates in the Jeannotte river. A great part of the shores of both lake and river are still clothed in primeval forests, but the busy saw-mill at Lake Edward, with its daily consumption of five hundred logs, is fast eating up this old growth and leaving behind only white birch and small second-growth spruce and fir.

This forest contains very few species of trees, of which the white birch is the commonest, with spruce and fir in about equal numbers next, and now and then a solitary white pine. The mountain ash and the spiked maple are very common, but hardly attain to the dignity of trees. In many places where the forest has been burnt a dense growth of raspberry bushes and dwarf cherry immediately springs up, and it is many years before the trees again take possession of the land. The monotony of the forest is here and there broken by little alder swamps along the many brooks, or by open sphagnum barrens with their clumps of *Ledum latifolium* and *Kalmia glauca.* In this northern latitude the fallen trees lie on the ground for a long time without decaying, and the accumulation of centuries covered by a luxuriant growth of moss makes walking through the forest a matter of the greatest difficulty. There are no roads anywhere, all the logging being done by water, but the abundance of lakes connected by rivers or brooks makes the country very accessible by canoe.

Trapping in the northern forest in the tangled mass of fallen trees and granite boulders covered by a deep growth of moss is a very different thing from trapping in open country. In the open southern woods, with but little rubbish on the ground, one takes as much in traps that have been set a week or ten days in one spot as one does the first day, and when the supply is used up, it is then little use to move the trap, as all the small mammals from near about have already found it. It is not so in the northern forest, where distance means much more and the small mammals are very local and do not travel far. The first day or two will exhaust the supply in one spot, but a move of only a few yards will again yield specimens in about the same number.

We were disappointed in not getting *Phenacomys*, but it is possible that the animal does occur here locally.

There were a few mammals we knew to occur in the immediate vicinity of Lake Edward that we were unable to get, and perhaps it is as well to mention these. Flying squirrels and chipmunks were said by the Indians and French Canadians to occur, but we saw none. Moose and caribou were both quite plentiful. I found a fresh caribou track one morning where the animal had come out of the forest and walked along the railroad for about a mile.

The red fox was abundant, and we found many signs. The section man on the railroad told me foxes were sometimes killed by the train, and that he had picked them up on several occasions when going over the road on his hand-car in the morning. The trappers get otter every winter, and the black bear is fairly common. The wolverine is still sometimes met with and occasionally this expert trap robber proves a great nuisance to the trapper in the winter by finding his line of deadfalls, following it up, demolishing every one, and eating the bait and any animal that may have been caught.

Sciurus hudsonicus Erxl. Red Squirrel. 5 specimens.

Red squirrels were extremely abundant and a great nuisance, as they persisted in getting into our mouse traps, and as the traps were usually not strong enough to kill them outright they carried away a great many. A few that were caught around the neck in the Schuyler mouse traps were killed. We also caught a great number in steel traps baited with salt pork or meat.

Castor canadensis Kuhl. American Beaver. 3 specimens.

Beaver are still quite common in all this region, but are relentlessly pursued by the Indians and are decreasing very fast. The nearest beaver to Lake Edward were on the Jeannotte river. We were too busy to go after them ourselves and so hired two Indians and sent them down the Jeannotte. In five days they returned with a whole family of beaver—an old male and female and three young. Unfortunately they had utterly ruined the old female and one of the young by shooting them in the heads with their rifles. The old male was a very fine, large beaver and according to the Indians was five years old. The specimen measured: total length, 1,130; tail, 410; hind foot, 176.

The same two Indians, in the winter of 1894-1895, killed sixty beaver and told me they expected to get about forty this winter. In addition to the Indians, there are many other trappers working this country every season with great thoroughness, and the beaver stand but a poor chance.

Synaptomys fatuus sp. nov. Northern Lemming Mouse. 9 specimens.

Type No. 3857, coll. of E. A. and O. Bangs; female adult, from Lake Edward, Quebec, September 28, 1895. Total length, 125; tail, 16; hind foot, 19. E. A. and O. Bangs, collectors.

General characters.—Slightly smaller and darker than *S. cooperi*, with smaller and lighter skull and much narrower and shorter incisors. Coat very long and full.

Color.—Upper parts sepia brown, thickly interspersed with black-tipped hairs; under parts slate gray, with in places a slight brownish tinge; feet drab; tail nearly unicolor, slightly paler below, darker at the tip, and sparsely haired.

Skull.—The skull, as compared with that of *S. cooperi*, is rather smaller and narrower, with less spread to the zygomata and more slender rostrum.

Teeth.—The molar teeth are substantially the same as in *S. cooperi*, but the incisors are very much narrower and shorter.

Measurements of nine Specimens of S. fatuus.

No.	Sex and age.	Date.	Total length.	Tail.	Hind foot.
3857	♀ ad.......	Sept. 25, 1895	125	16	19
3855	♂ yg. ad...	Sept. 27, 1895	114	11 (bobtail)	18
3854	♂ ad.......	Sept. 24, 1895	123	20	18.5
3858	♀ yg. ad...	Sept. 27, 1895	114	15	17.5
3859	♀ yg. ad...	Sept. 24, 1895	113	19	19
3856	♀ yg. ad...	Sept. 27, 1895	114	15	17
3861	♂ yg......	Sept. 19, 1895	110	17.5	18
3860	♂ yg......	Sept. 17, 1895	111	16	18
3862	♂ yg......	Sept. 25, 1895	93	15	17

This strange little animal was common about Lake Edward and inhabited every variety of country—the sphagnum bogs, the deep spruce forest, and the banks of little streams. It lived everywhere in the deep moss. It was hard to trap and seemed not to care for any kind of bait, but blundered into the traps that happened to be in its way. We caught thirteen examples of *S. fatuus*, four of which were so badly eaten by shrews or mice as to be worthless.

Microtus fontigenus * sp. nov. Forest Meadow Mouse. 8 specimens.

Type No. 3837, coll. of E. A. and O. Bangs, female adult from Lake Edward, Quebec, September 28, 1895. Total length, 151; tail. 41.25; hind foot, 21. E. A. and O. Bangs, collectors.

General characters.—Size small; colors dark, with no rufous shades; rostrum very slender; audital bullæ very large and round.

Color.—Upper parts dark sepia brown, with a slight admixture of black-tipped hairs; under parts olive gray to smoke gray; tail sparsely haired and bicolor, black above, gray beneath.

Skull.—The skull is small, with very slender rostrum, and differs from that of any *Microtus* I am familiar with in having very large and round audital bullæ, about as in the genus *Evotomys*. The basioccipital is narrow and does not have a distinct median keel.

Teeth.—The pattern of enamel folding of the molar teeth is substantially as in *M. pennsylvanicus*.

Size.—No. 3837, female adult (type): total length, 151; tail, 41.5; hind foot, 21. No. 3840, male adult: total length, 150; tail vertebræ, 45; hind foot, 21.

This *Microtus* was not common. We found it usually along the banks of the little spring brooks in the deep forest and in small sphagnum bogs, where it lived under old logs or in holes in the moss, after the manner of an *Evotomys*. Nowhere did it make runways like those of *M. pennsylvanicus*, and it appeared to be confined to the forest. I hunted in vain the marshy spots and alder swamps and the cleared fields, places *M. pennsylvanicus* would have delighted in, but found no trace of any *Microtus* there, and trapping in such localities yielded nothing but shrews. We caught only eight examples of *M. fontigenus.*

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* Fontigena = born beside springs or fountain heads; a poetical term applied to the Muses, and therefore appearing in literature only in the feminine.

Microtus chrotorrhinus (Miller). Rufous-nosed Meadow Mouse. 9 specimens.

This beautiful little inhabitant of the deep spruce forest was not common. I consider it one of the rarest of our small mammals. It is easy to catch, and a day or two of trapping in any place is usually sufficient to capture all that are there. *M. chrotorrhinus* is apparently wholly diurnal. On account of the depredations of shrews I visited our traps regularly twice a day—once at daylight in the morning and again just before dark. I never found a *chrotorrhinus* on any morning visit. Although these specimens were taken nearly three hundred miles north of the type locality (Mt Washington, New Hampshire), they are in every way typical and show no approach to *M. xanthognathus.*

Fiber zibethicus (L.) Muskrat. 9 specimens.

Exceedingly abundant on all the marshy shores of the lakes and rivers. We set a line of sixteen traps one afternoon and on visiting them next morning found fourteen muskrats. One trap I set on a floating log that lay across a little brook where it emptied into Lake Edward and caught a muskrat in it every night during our stay.

Evotomys gapperi (Vig.). Red-backed Mouse. 36 specimens.

The commonest small mammal at Lake Edward. The red-backed mouse of this region is the small, dark-colored form of the spruce belt, true *gapperi.*

Evotomys fuscodorsalis Allen. Dusky-backed mouse. 4 specimens.

Apparently this little known *Evotomys* was rare, four examples being all we caught. These were taken in two localities about three miles apart and two in each place. In both places they were caught among loose boulders on side hills covered by moss and overgrown by spruce, fir, and white birch.

Peromyscus canadensis abietorum subsp. nov. Hudsonian White-footed Mouse. 4 specimens.

Type No. 2205, coll. of E. A. and O. Bangs, female adult, from James river, Nova Scotia. Coll. by C. H. Goldthwaite, August 8, 1894. Total length, 200; tail, 103; hind foot, 20 (measured in flesh by collector).

General characters.—Similar to *Peromyscus canadensis* (Miller), from which it differs in being a uniform dark gray above in both young and adult, never showing the russet and yellowish shades of old examples of *P. canadensis.*

Color.—Old adult: upper parts dark smoke gray, slightly darker along the middle of the back, causing an indistinct median band; under parts white, the hairs plumbeous at their base; feet and hands white; tail bicolored, black above, white below, hairy, and longer than the head and body; pencil long.

The size, proportions, and skull are the same as in true *canadensis.*

This white-footed mouse is the Northern representative of *P. canadensis*, which it resembles very closely in everything but color. When a large series of each is laid out side by side the difference in color is very striking, the uniform gray of the adults of *abietorum* being in marked contrast to the russet and yellow shades of the adults of *canadensis. P. abietorum* has a wide range in the spruce and fir forests of the north. It was not common at Lake Edward, and, as all we caught were immature, I have taken for the type a fine old adult from James river, Nova Scotia, from whence I have a good series, collected by Mr. C. H. Goldthwaite in the summer of 1894.

Zapus insignis Miller. Woodland Jumping Mouse. 1 specimen.

Either *Zapus insignis* was very rare at Lake Edward or they had already hibernated, the weather being quite cold, with a heavy frost nearly every night during our stay. This species is very easy to catch and we set many traps in its favorite haunts along the little brooks in the forest. The only one caught was exceedingly fat.

Lepus americanus Erxl. American Hare. 4 specimens.

Very abundant. We caught a number in steel traps baited with salt pork. These traps were set after the Indian fashion, a semicircle of slabs cut from the spruces being set up and the top covered over with spruce boughs. The bait was put inside and the trap in the opening. One morning I shot a hare asleep on top of a board fence three feet high, beside the railroad in the settlement. How he could have jumped onto this fence and balanced himself there is a mystery.

Vespertilio subulatus Say. Bat. 1 specimen.

Two bats of this species flew into the house on different evenings.

Blarina brevicauda (Say). Short-tailed Shrew. 5 specimens.

Common everywhere.

Sorex (**Microsorex**) **hoyi** Baird. Hoy's Shrew. 1 specimen.

Apparently rare.

Sorex (**Neosorex**) **albibarbis** (Cope). Water Shrew. 1 specimen.

Apparently rare.

Sorex personatus Geoff. St. Hilaire. Common Shrew. 18 specimens.

Extremely abundant and inhabiting every variety of country.

Condylura cristata (L.) Star-nosed Mole. 1 specimen.

No work of this mole was seen anywhere. The one taken was caught in a cyclone trap set under an old log. Probably the animal lives below the deep layer of moss with which everything is covered, and therefore gives no sign of its presence.

Mephitis mephitica (Shaw). Hudsonian Skunk. 5 specimens.

Skunks were common about the settlement. We trapped four and took another skull from an animal that had been killed some months previously. These skunks are highly interesting, being extreme examples of the Northern short-tailed form to which I have restricted Shaw's name *mephitica.** They measure as follows:

No.	Sex and age.	Total length.	Tail.	Hind foot.
3801	♂ old ad................	585	193	75
3803	♂ ad....................	617	202	79
3804	♂ ad....................	592	202	76
3802	♀ old ad................	565	159	75

The skulls of all lack the median palatal spine usually seen in the skulls of Southern skunks.

Putorius (**Lutreola**) **vison** (Schreber). Little Black Mink. 6 specimens.

Mink were abundant in spite of the fact that great numbers are trapped every winter. All we took are very small and dark-colored and are extreme examples of the beautiful northern form, true *vison.*

Putorius (**Gale**) **richardsoni cicognani** (Bp.) Small Brown Weasel. 3 specimens.

We caught four of these little weasels, but one was partly eaten and ruined by some animal. All were caught in traps set for marten and baited with salt pork.

Mustela americana Turton. Marten or Sable. 1 specimen.

We set many traps for this elusive pirate of the forest, but succeeded in catching only one, a very dark-colored old female.

It is of interest that the trappers here never get the fisher (*M. pennanti*) and say that it does not occur at all in this whole region.

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*Proc. Bost. Soc. Nat. Hist., vol. XXVI. Author's edition, July 31, 1895, p. 5.

Cranial Measurements of Synaptomys fatuus, S. cooperi, and Microtus fontigenus.

Number.	Sex and age.	Locality.	Basilar length (basion to front of premaxillary).	Basilar length of Hensel.	Occipito-nasal length.	Zygomatic breadth.	Mastoid breadth.	Interorbital breadth.	Greatest height of cranium above palate.	Greatest height of cranium above lip of foramen magnum.	Length of upper molar series on alveoli.	Greatest length of single half of mandible.	Breadth of muzzle at root of zygoma.
Synaptomys fatuus Bangs.													
3857	Type ♀ ad.	Quebec, Lake Edward	24.0	23.0	26.0	15.2	11.8	3.0	8.2	6.2	6 6	15.8	5.2
3854	♂ ad	" " "	23.4	22.0	25 0	15.8	12.0	3.2	8.4	6.2	6.8	16.0	5.0
3855	♂ ad	" " "	23.6	21.8	25.0	15.6	11.8	3.2	7.8	6.0	6.2	15.4	5.0
3856	♀ yg. ad	" " "	22.6	21.4	24.2	14 4	11.4	3.0	7 8	6.2	6.8	15.2	4.8
3858	♀ yg. ad	" " "	22.0	20.2	23.0	14.2	11 4	3.0	7.6	6.0	6.2	15.2	4.4
Synaptomys cooperi Baird.													
1037	♂ ad	Massachusetts, Wareham	24.0	22.2	25.0	16.6	12 2	3 2	8.4	7.0	7.0	16.0	5.2
215	♀ ad	" "	24.2	22.8	25.8	16.8	13.0	3.2	8.6	7.0	6.8	16.0	5.4
Microtus fontigenus Bangs.													
3837	Type ♀ ad.	Quebec, Lake Edward	24 4	23.2	25.6	14.0	11.2	3.8	8.4	7.0	6.2	15.6	4 2
3840	♂ ad	" " "	23 4	22.4	24.4	14.2	11.6	3.4	7.8	7.0	6.2	15.8	4.8
3839	♂ ad	" " "	23.4	22.0	24.8	14 2	11.6	3.6	7.8	6.8	6.2	15.0	4 4
3841	♂ ad	" " "	23.2	22.0	....	13.8	11.0	3.8	8.0	7.0	6.2	15.2	4.4
3838	♀ ad	" " "	24.0	23.0	25.0	14.2	11.4	....	8.2	7.0	6.4	15 8	4.6

VOL. X, PP. 53-54 MARCH 14, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

DESCRIPTION OF A NEW SPECIES OF PLOVER FROM THE EAST COAST OF MADAGASCAR.

BY CHARLES W. RICHMOND.

The apparently new species of plover here described is represented in the United States National Museum series by five specimens. Three of these were in a collection of birds lately received from Dr. W. L. Abbott; the other two were obtained by exchange some years ago from the Paris Museum.

Ægialitis thoracica sp. nov.

Type No. 151,174, U. S. National Museum, ♀ adult, Loholoka, east coast of Madagascar, June 3, 1895. Dr. W. L. Abbott, collector.

Crown, back, scapulars, tertials, and wing-coverts hair brown, the feathers edged with pale or deep buff, those of the greater wing-coverts edged and tipped with white; primaries, secondaries, rump, median upper tail-coverts, and middle rectrices dark clove brown; shafts of primaries (including the third) with white on terminal half; primary coverts brownish black, tipped with white; lateral upper tail-coverts white; inner primaries narrowly bordered on inner web and tipped with white; base of outer webs white; secondaries tipped with white, which become broader toward the innermost. Forehead, lores, cheeks, throat, axillars, under wing-coverts, sides of body, and flanks white; a line from upper mandible to lower anterior border of eye, continued posteriorly through and including ear-coverts black, connecting with a narrower black band extending across lower border of nape, and with a broad black pectoral band, the latter more extensive on sides of chest; an interocular crescent-shaped black band borders the white forehead and separates it from a white line over eyes, ear-coverts, and passing across nape as a conspicuous ruchal band (leaving the black crown patch entirely surrounded by a white band and the latter isolated from other white markings); a white band below the black pectoral band passes abruptly into cinnamon buff on the abdomen and under tail-coverts, that of the abdomen extends up on sides of body to the black band across breast, intercepting the white. Three outer tail feathers white, with more or less dusky markings, especially on the two inner ones; next inner pair (4th) dusky, with white tips; 5th pair hair brown, becoming black subterminally, with a deep buff tip. Bill, legs, and feet black in dried skin. Wing, 4.00; tail, 1.72; tarsus, 1.20; culmen (exposed), .69 inches.

In another female (No. 151,169) the wing measures 4.20 inches; the other measurements of the five specimens are very much the same.

This species seems to be most nearly related to *Ægialitis varia* (Vieillot) of Africa, and also found in Madagascar, but differs from it mainly in the presence of the black pectoral band and the absence of a wholly black shaft in the third primary; the white line posterior to the black crescent between eyes is more pronounced and the lesser wing-coverts and primary coverts are not decidedly blackish. There is also a slight difference in size, particularly noticeable in the bills.

The two specimens received from the Paris Museum are sexed as males, and are precisely similar to those collected by Dr. Abbott. They were collected by M. Lantz, in 1882, on the southeast coast of Madagascar. In addition to this information the labels bear the names '*Charadrius tenellus*,' and, in a later handwriting, '*pecuarius*' [= *varia*].

From an examination of the specimens in the National Museum and a careful comparison of descriptions, it appears that no described plumages of either *Ægialitis tenella* or *Æ. varia* possess black pectoral bands.

I was rather loth to consider the species unnamed after examining the two specimens from the Paris Museum, as the bird must be well known to the French authors, particularly Milne-Edwards and Grandidier, whose great work on Madagascar birds I have had no opportunity to consult. Thinking there might be some reference to the black pectoral band in the account of *Æ. varia* in this work, I wrote to Mr. Witmer Stone, of the Philadelphia Academy, who has access to it, and he has very kindly furnished me with the following extract* under *Charadrius pecuarius* Temm. (as they prefer to write it):

"Ce Pluvier africain se trouve aussi à Madagascar, sur les côtes de l'est comme sur celles de l'ouest. Il est en dessus d'un brun roussâtre clair avec une couronne blanche autour de la tête qu'un diademe noirâtre separe du front, qui est également blanc ainsi que les joues; la gorge, la poitrine, que traverse, chez les adultes, une large bande noire, et les sous-caudales, sont blanches; le ventre est roussâtre. Cette bande noire qui traverse la poitrine chez les adultes n'a pas encore été signalée chez les individus Africains."

It is very remarkable that the black pectoral band should be present in adults from Madagascar and absent in those from Africa, where the species is said to be common in many places and breeds and from whence it was originally described.

The two species, *varia* and *thoracica*, are apparently found together on the east coast of Madagascar, where Dr. Abbott collected a specimen of each at Loholoka on June 3. It was probably this association of the species that led the authors of the above-mentioned work to consider them adult and young of one species.

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* Hist. Phys. Nat. et Polit. de Madagascar, XII, Ois. tome I, pp. 511–512.

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VOL. X, PP. 55-64 MARCH 19, 1896

PROCEEDINGS

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BIOLOGICAL SOCIETY OF WASHINGTON

REVISION OF THE LEMMINGS OF THE GENUS *SYNAPTOMYS*, WITH DESCRIPTIONS OF NEW SPECIES.

BY DR. C. HART MERRIAM.

The genus *Synaptomys* has an interesting history. It was described by Professor Baird about forty years ago from a specimen received from William Cooper, of Hoboken, New Jersey, for whom the species was named *Synaptomys cooperi.*[1] The locality at which it was collected is unknown. For many years the species continued to elude the notice of naturalists, and it was not until 1874 that additional information was published concerning it. In this year Coues recorded specimens from Indiana, Illinois, Minnesota, and Kansas. He also mentioned specimens from Oregon [= Washington] and Alaska; but these, as will be shown later, do not belong to the present species.[2]

In 1881 Dr. F. W. Langdon recorded its occurrence "in numbers" at Brookville, Indiana, and described the locality at which it had been found by E. R. Quick.[4]

In 1885 Edgar R. Quick and Amos W. Butler described its habits as observed at Brookville, Indiana.[5]

In December, 1892, I published a notice of the occurrence of the species on Roan Mountain, North Carolina, and of the discovery of its remains in 'pellets' of the long-eared owl found in Virginia, near Washington, D. C., by Dr. A. K. Fisher, and of others taken from the stomachs of hawks and owls killed at Sandy Spring, Maryland, and Alfred Center, New York.[6] At the close of this paper I suggested that mammal collectors would "do well to keep a sharp lookout for this species in the cooler parts of Pennsylvania and New Jersey."

In January, 1893, S. N. Rhoads recorded the species from May

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[1] The numeral references in the present paper refer to titles in the bibliography at the end of the article.

Landing, New Jersey, but unfortunately gave it a new name, *Synaptomys stonei.** [7] In the same year (1893) J. B. Steere recorded it from Ann Arbor, Michigan.[8]

In April, 1894, Outram Bangs recorded specimens from Wareham and Plymouth, Massachusetts, and showed that *S. stonei* is the same as *S. cooperi* Baird.[9]

In December, 1894, J. A. Allen recorded the northward extension of *Synaptomys* to Andover and Gulquac Lake, New Brunswick.[12]

Early in January, 1895, S. N. Rhoads published a record of the capture of a specimen of *S. cooperi* on Big Bushkill creek, Monroe county, Pennsylvania.[13] This completes, so far as I am aware, the published records of the type species.

Although remains of the species had been found both in 'pellets' and stomachs of hawks and owls from the vicinity of Washington, D. C., and although the species had been persistently trapped for by a number of experienced mammal collectors, still no specimen 'in the flesh' was actually obtained until February of the present year (1896), when Vernon Bailey captured several in a sphagnum bog at Hyattsville, Maryland, only seven miles from Washington. Mr. Bailey has also secured a number at Elk River, Minnesota, and I have a specimen from Knoxville, Iowa.

During recent explorations in the great Dismal Swamp in southern Virginia, Dr. A. K. Fisher secured specimens of a new *Synaptomys*, which is here described under the name *S. helaletes.*

Specimens collected at Neosho, Kansas, many years ago by the late Captain B. F. Goss, and labeled *S. gossii* by Baird, are here described as a subspecies under that name.

A few months ago Napoleon A. Comeau, of Godbout, on the north shore of the St. Lawrence, near the Gulf, sent me a specimen of *Synaptomys* which differs materially from *S. cooperi.* This animal has just been described by Outram Bangs under the name *S. fatuus*, from specimens collected by him at Lake Edward, Quebec.[14] Dr. Allen's New Brunswick specimens, which he has kindly loaned me for examination, also belong to this northern form. It is not improbable that all of the four forms here recognized will be found to intergrade.

In 1894 F. W. True described a new lemming mouse collected by Lucien M. Turner at Fort Chimo, Ungava, and named it *Mic-*

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* In the same paper Mr. Rhoads stated that the species "had previously been detected by the U. S. Department of Agriculture in the rejects of a barn owl living in the tower of the Smithsonian Institution" (Am. Nat., Jan., 1893, 53). This statement was unauthorized and incorrect.

tomys innuitus.[10] The characters that separate it from *Synaptomys* proper seem of subgeneric rather than generic weight, and in the present paper *Mictomys* is treated as a subgenus of *Synaptomys.*

In 1874,[2] and again in 1877,[3] Coues referred to *Synaptomys cooperi*, a specimen from Skagit valley, Washington, collected in 1859 by C. B. Kennerly, and one from Nulato, Alaska, collected in 1867 by William H. Dall. These specimens are still in the U. S. National Museum, and through the courtesy of Mr. True I have been enabled to compare them with his type of *Mictomys innuitus*, which they closely resemble. Both belong to the subgenus *Mictomys*, but differ sufficiently from *innuitus* and from each other to warrant separation. They are here described under the names *truei* and *dalli.*

In September, 1895, Clark P. Streator collected, at Wrangel, Alaska, still another member of the same group, which is here named *wrangeli.*

Summary.—The material now available shows that the genus *Synaptomys*, instead of being monotypic, as until recently supposed, comprises 2 well marked subgeneric groups—*Synaptomys* proper and *Mictomys;* that *Synaptomys* proper inhabits eastern Canada and the northeastern United States from Minnesota to New Brunswick and New England, and contains 4 fairly well defined forms; that *Mictomys* has a transcontinental distribution from Labrador to Alaska, and contains at least 4 species.

Synaptomys, like the other genera of lemmings, is a distinctly boreal group. Of the two subgenera, *Mictomys* is decidedly the more boreal, being strictly confined, in the east at least, to the Hudsonian zone. The subgenus *Synaptomys* pushes southward to the northern edge of the Austroriparian zone, but after it leaves the Boreal zone it occurs only, so far as known, in cool swamps.

Genus SYNAPTOMYS Baird.

Subgenus *Synaptomys* Baird, 1857.

Inferior molars with well defined closed enamel loops on outer side; upper incisors very broad and heavy, with enamel face deep orange throughout; posterior end of palate without median azygos ridge or projection.

Subgenus *Mictomys* True, 1894.

Inferior molars with no closed enamel loops on outer side; upper incisors relatively narrow and weak, with enamel face pale yellow and part on outer side of sulcus nearly white; posterior end of palate with a strongly marked median azygos ridge and projection.

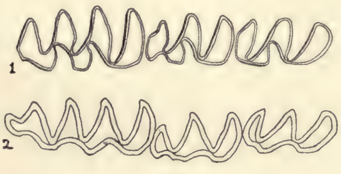

FIG. 1.—Enamel pattern of lower molars.
1. *Synaptomys* 2. *Mictomys.*

Subgenus SYNAPTOMYS Baird.

Synaptomys cooperi Baird.

Synaptomys cooperi Baird, Mammals N. Am., pp. 556–558, 1857.
Coues, Proc. Acad. Nat. Sci., Phila., p. 194, 1874; Monog. N. Am. Rodentia, pp. 235–236, 1877.
Quick and Butler, Am. Naturalist, XIX, 113–115, Feb., 1885.
Merriam, Proc. Biol. Soc. Wash., VII, 175–177, Dec., 1892.
Bangs, Proc. Biol. Soc. Wash., IX, 99–104, April, 1894.
Synaptomys stonei Rhoads, Am. Naturalist, XXVII, pp. 53–54, Jan. 11, 1893.

Type locality unknown; probably northern New Jersey or southern New York.

Geographic distribution.—Boreal and parts of Transition zones from Minnesota eastward to eastern Massachusetts and south to Iowa, Indiana, and Maryland, and in the mountains to North Carolina and Tennessee. South of the Boreal zone it appears to be confined to cold sphagnum swamps, which give it a boreal atmosphere.

General characters.—Similar in size and general appearance to *Microtus pennsylvanicus*, but tail very much shorter. Contrasted with *Synaptomys helaletes* the feet are smaller and the rostrum, mandible, and upper incisors are much narrower and less massive.

Color.—Upper parts grizzled gray and yellowish brown abundantly mixed with black-tipped hairs; under parts soiled whitish, the plumbeous under fur showing through; tail bicolor; brownish above, whitish below. In the adult the color of the back varies from pale yellowish brown to almost rusty, always 'grizzled' by a bountiful admixture of black-tipped hairs. In the young the color is at first very dark, almost blackish slate; it then becomes grayish brown and approaches sepia before taking on the yellowish brown of the adult.

Cranial and dental characters.—Contrasted with *S. helaletes* from Dismal Swamp, the skull and teeth of *S. cooperi* are smaller and weaker, the zygomata more bowed outward, the rostrum and mandible very much narrower, the nasals narrower posteriorly, and the brain case shorter.

Measurements.—Average of 4 specimens from Ann Arbor, Michigan: total length, 118; tail vertebræ, 17.5; hind foot, 18. Average of 2 from Roan Mountain, North Carolina: Total length, 121; tail vertebræ, 20; hind foot, 19.5.

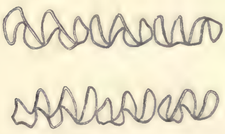

FIG. 2.—Enamel pattern of upper and lower molars in *Synaptomys cooperi*.

Synaptomys fatuus Bangs.

Synaptomys fatuus Bangs, Proc. Biol. Soc. Wash., X, 47–48, March 7, 1896.

Type locality.—Lake Edward, Quebec.

Geographic distribution.—Hudsonian zone from Lake Edward, Quebec (and probably much farther west), to Victoria county, New Brunswick, and Godbout, Quebec. Limits of range unknown.

General characters.—Similar to *S. cooperi*, but slightly smaller; skull decidedly smaller, with much narrower upper incisors.

Color.—Upper parts grizzled yellowish brown, abundantly mixed with black-tipped hairs; under parts varying from slate gray to whitish, washed with buff on the belly; tail nearly concolor, only slightly paler below than above.

Cranial and dental characters.—Skull similar to that of *S. cooperi*, but smaller and weaker; rostrum narrower; basisphenoid broader posteriorly. Upper incisors very much narrower than in *cooperi.*

Measurements.—Average of 2 adults from type locality (measured in flesh by O. Bangs): total length, 124; tail vertebræ, 18; hind foot, 18.7. Measurements of an alcoholic specimen (♀) from Godbout, Quebec: total length, 106; tail vertebræ, 19; hind foot, 18.

Synaptomys helaletes sp. nov.

Type from Dismal Swamp, Virginia, No. 75172, ♀ adult, U. S. National Museum, Department of Agriculture collection. Collected October 14, 1895, by Dr. A. K. Fisher. Original number 1818.

General characters.—Similar to *S. cooperi*, but with larger head and feet, longer tail, much broader rostrum and mandible, and larger and more massive skull and teeth.

Color.—Upper parts grizzled gray and yellowish brown, abundantly mixed with black-tipped hairs; under parts plumbeous, washed with white; tail bicolor, brownish above, whitish below; toes usually partly white.

Cranial and dental characters.— Contrasted with *S. cooperi*, the skull and teeth are larger, heavier, and more massive; the zygomata less strongly bowed outward; the nasals broader posteriorly, and the brain case longer. The rostrum, upper incisors, and under jaw are remarkable for breadth and massiveness.

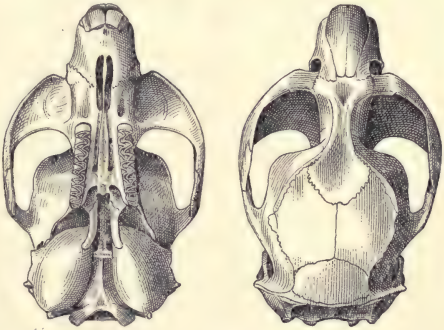

FIG. 3.—Skull of *Synaptomys helaletes* ♀ (type) × 1½.

Measurements.—Type specimen: total length, 125; tail vertebræ, 22; hind foot, 20. Average of four adults from type locality: total length, 118.5; tail vertebræ, 21; hind foot, 20.2.

General remarks.—*Synaptomys helaletes*, while of essentially the same size as *S. cooperi*, has very much larger fore and hind feet and a longer tail. The difference in the breadth and massiveness of the rostrum, mandible, and upper incisors is so great that skulls of the two require no comparison. Still, specimens recently collected by Vernon Bailey in a sphagnum swamp near Washington, D. C., are somewhat intermediate and indicate that intergradation may exist.

Synaptomys helaletes gossii subsp. nov.

Arvicola (*Synaptomys*) *gossii* Baird MS., Coues, Monog. N. Am. Rodentia, p. 235, 1877 (*nomen nudum*).

Type locality.—Neosho Falls, Kansas, No. 6915, ♂ old, U. S. National Museum. Collected by B. F. Goss, 1866.

General characters.—Similar to *S. helaletes*, but color probably redder; rostrum longer; audital bullæ smaller.

Color.—Not positively known; probably more reddish brown than in *cooperi* or *helaletes*. The mounted specimen in the National Museum has been skinned out of alcohol, and the skins originally collected by Captain Goss cannot be found.

Cranial and dental characters.—Skull as a whole similar to that of *S. helaletes*, but even larger, with rostrum and nasals longer; zygomata more bowed outward in the middle; orbital fossæ larger; audital bullæ smaller; postpalatal pits deeper, defining a distinct median ridge between them, which ridge projects slightly into the postpalatal notch. Viewed from below, the rostrum and incisive foramina are conspicuously longer. Owing to the small size of the audital bullæ, the sides of the basioccipital are less deeply excavated, and the vacuity on each side of the basisphenoid is much larger than in *helaletes*; the incisors are very broad and heavy, as in *helaletes*, and the molars nearly as large (the upper series measuring 7 mm.).

Measurements.—Average of 6 specimens from type locality: total length, 120; tail vertebræ, 20.5; hind foot, 19.*

Subgenus MICTOMYS True.

A new and exceedingly interesting lemming-vole from Ungava, Labrador, was described by Mr. F. W. True, in 1894, under the name *Mictomys innuitus*. On comparing the type specimen of this species and specimens of the two related species here described, with *Synaptomys cooperi*, it appears that the most important character separating *Mictomys* from *Synaptomys* is the absence of closed triangles or enamel loops on the outer side of the lower molars (Fig. 1). In addition, the upper incisors in *Mictomys* are more slender and much paler in color, and the part exterior to the sulcus is nearly white, while in *Synaptomys* the whole enamel face is deep orange. The chief cranial differences are in the post-palatal region. In *Mictomys* there is a distinct median azygos ridge not present in *Synaptomys*,† where the palate breaks down to the interpterygoid notch. This ridge separates the post-palatal pits and projects backward into the post-palatal notch. In *Mictomys* the supraorbital ridges unite in a single median ridge; in *Synaptomys* they are normally separated by a sulcus.

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* Hind foot from alcoholics; the other measurements taken in flesh by Captain Goss and converted from Coues' table, N. Am. Rodentia, p. 236, 1877.

† Except in *S. gossii* in which the post-palatal pits are so deep that the median part of the palate between them is left as a nearly vertical projection comparable to, but much shorter than, that of *Mictomys*.

The differences in enamel pattern of the molar teeth in the four species of *Mictomys* now known are shown in the accompanying illustration (Fig. 4). The teeth are large and broad in *M. innuitus* and *dalli;* smaller and much narrower in *wrangeli* and *truei*. The reëntrant angles on the outer side of the lower molars are deepest in *truei* (*d′*); shallowest in *wrangeli* (*b′*).

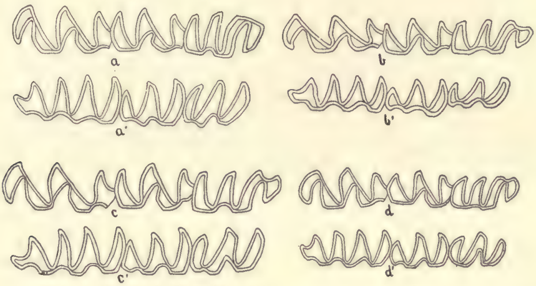

FIG. 4.—Enamel pattern of molar teeth in type specimens of *Mictomys*. × 5.

a, *b*, *c*, *d*, upper series; *a′*, *b′*, *c′*, *d′*, lower series.
a. *Mictomys innuitus*, Ft. Chimo, Ungava.
b. *Mictomys wrangeli*, Wrangel, Alaska.
c. *Mictomys dalli*, Nulato, Alaska.
d. *Mictomys truei*, Skagit Valley, Washington.

Synaptomys (Mictomys) innuitus True.

Mictomys innuitus True, Proc. U. S. Nat. Mus., XVII, 243, April 26, 1894.

Type locality.—Fort Chimo, Ungava, Labrador.

General characters.—Size and general appearance similar to *Synaptomys cooperi;* ear slightly longer than in *Synaptomys;* tail shortest of the four known species of *Mictomys.*

Color (of alcoholic).—"Upper surfaces grayish brown, as in *Synaptomys;* under surfaces gray; face pale brown; lips, end of nose, and chin white; feet pale brown; tail bicolored, pale brown above, white below." From continued immersion in alcohol the color of the upper parts has now changed to reddish brown.

Cranial and dental characters.—Skull as a whole very broad and flat; brain case strongly depressed; zygomata broadly spreading and standing out squarely from rostrum; audital bullæ strongly inflated anteriorly, the anterior border strongly convex forward. Contrasted with *M. wrangeli,* the posterior loop of the last upper molar is longer transversely, and the reëntrant angles of the middle and last lower molars are deeper.

Measurements of type specimen (alcoholic, measured by C. H. M.).—Total length, 115; tail vertebræ, 17; hind foot, 17.5.

Synaptomys (**Mictomys**) **dalli** sp. nov.

Type locality.—Nulato, Alaska, No. 10957, ♂ adult [skeleton from alcohol], U. S. National Museum. Collected February, 1867, by Wm. H. Dall.

General characters.—Similar to *M. wrangeli*, but differing in cranial characters.

Color.—Unknown.

Cranial and dental characters.—Skull similar to that of *wrangeli*, but differing in the following particulars: nasals emarginate instead of truncate posteriorly; interparietal much narrower anteroposteriorly and acute at both ends; brain case broader; interorbital constriction broader; zygomatic expansion slightly larger; *audital bullæ much larger* and more fully inflated, with corresponding reduction in breadth of basioccipital and basisphenoid; *mandible conspicuously larger, broader, and heavier*, particularly as seen from below; upper and lower molars conspicuously larger; middle and last lower molars with reëntrant angle on outer side decidedly deeper than in *wrangeli*, and thus resembling *truei;* posterior loop of last upper molar as in *wrangeli.*

Measurements (estimated from skeleton).—Total length, 115; tail vertebræ, 22; hind foot, 19.

General remarks.—In looking at the skull of *M. dalli* from above and comparing it with the type of *M. wrangeli*, the only conspicuous differences are the greater breadth of the brain case and interorbital constriction. Looked at from below, the large size of the audital bullæ and molar teeth is striking. On comparing the under jaws, one is also impressed by the disproportionally large size of the mandible and molars of *dalli.* I have named the species in honor of Dr. William H. Dall, who collected it at Nulato, Alaska, nearly thirty years ago.

Synaptomys (**Mictomys**) **truei** sp. nov.

Type from Skagit Valley, Washington, No. $\frac{3798}{12101}$, yg. ad., U. S. National Museum. Collected August 6, 1859, by Dr. C. B. Kennerly (probably in mountains bordering Skagit valley).

General characters.—Size and general appearance as in *S. wrangeli*, but ears slightly longer and color of upper parts more reddish brown. Last lower molar with a deep reëntrant angle on outer side.

Color.—Upper parts dull umber brown fading gradually to plumbeous of under parts; belly hairs tipped with whitish. Tail bicolor, dark above, whitish below. The type and only known specimen is in the molt and in very poor condition; hence the colors may not be as in the living animal.

Cranial and dental characters.—The skull of the type is nearly destroyed, leaving only the teeth in the broken jaws. The molar loops, both above and below, are much fuller and more bluntly rounded than in *innuitus* and *wrangeli*, and the reëntrant angle on the outer side of the last lower molar is much deeper and nearly forms a closed loop on the outer side of that tooth. The upper incisor is narrower and the sulcus shallower than in the other known species.

Measurements (from dry skin).—Total length, about 112; tail vertebræ, 22; hind foot, 18.

General remarks.—Mictomys truei differs markedly from the two other species now known in the fullness of the molar loops and the depth of the reëntrant angle on the outer side of the last lower molar. I have named the species in honor of Mr. F. W. True, curator of mammals in the U. S. National Museum.

Synaptomys (Mictomys) wrangeli sp. nov.

Type from Wrangel, Alaska, No. 74720, ♂ ad., U. S. National Museum, Department of Agriculture collection. Collected September 6, 1895, by Clark P. Streator. Original number 4871.

General characters.—Similar to *S. innuitus*, but larger; tail and hind foot longer; skull narrower.

Color.—Upper parts grizzled grayish brown, with a yellowish cast; under parts plumbeous, tippid with whitish; tail bicolor, brownish above, whitish below, darker at tip.

Cranial and dental characters.—The skull of *Mictomys wrangeli*, contrasted with that of *M. innuitus*, is narrower and higher; the zygomata narrower and less spreading anteriorly; brain case narrower and less depressed; audital bullæ less inflated anteriorly. The posterior loop of the last upper molar is much shorter; the reëntrant angle on outer side of last lower molar shallower, and the enamel folds of all the teeth more loosely spaced.

Measurements (taken in flesh).—Type specimen: total length, 122; tail vertebræ, 23; hind foot, 19. Average of two specimens from type locality: total length, 119.5; tail vertebræ, 22.5; hind foot, 19.

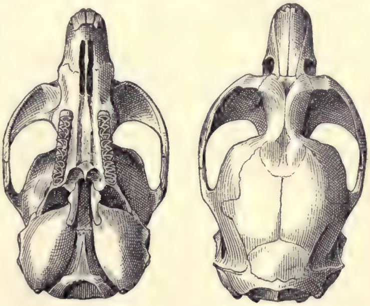

FIG. 5.—Skull of *Mictomys wrangeli* ♂ (type) × 1½.

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PRELIMINARY SYNOPSIS OF THE AMERICAN BEARS.

BY DR. C. HART MERRIAM.

Heretofore it has been customary to class the North American bears in three groups—Blacks, Grizzlies, and the Polar bear. The study of a series of more than 200 skulls, including about 35 skulls of the huge bears of the Alaska coast region, shows this classification to be inadequate and adds four strongly marked species to our fauna. The new species are: (1) the gigantic fish-eating bear of Kadiak Island and the Alaska Peninsula, *Ursus middendorffi* nob.; (2) the large brown bear of Yakutat Bay and the coastal slope of the St. Elias Alps, *Ursus dalli* nob.; (3) the large brown bear of Sitka and the neighboring islands (and perhaps the adjacent mainland also), *Ursus sitkensis* nob.; and (4) the Florida Black bear, *Ursus floridanus* nob.

In view of the remarkable characters presented by these new forms it becomes necessary to rearrange our bears. They may be classed in five well marked superspecific groups or types, as follows:

1. The Polar bear type, genus *Thalarctos* Gray.
2. The Black bear type, subgenus *Euarctos* Gray.
3. The Grizzly bear type, *Ursus horribilis* and its allies, subgenus *Danis* Gray.
4. The Sitka bear type, *Ursus sitkensis* nob. and *U. dalli* nob.
5. The Kadiak or Alaska Peninsula bear, *Ursus middendorffi* nob.

The five groups are unequally related: the Polar bear belongs to an independent genus; the Black bears are more different from the others, taken collectively, than the latter are from one another, and seem to be the only ones whose distinctive characters are of sufficient weight to entitle them to subgeneric recognition.

1. The Polar or Ice bear, *Thalarctos maritimus* (Linn.), inhabits the Arctic shores and islands of both continents and has not been subdivided.

2. The Black bears may be separated into at least 4 species having more or less circumscribed geographic ranges: (*a*) the common Black bear, *Ursus americanus* Pallas; (*b*) the Louisiana bear, *Ursus luteolus* Griffith; (*c*) the Florida bear, *Ursus floridanus* nob.; and (*d*) the St. Elias bear, *Ursus emmonsi* Dall. Some of these may be found to intergrade, and *Ursus americanus* may be still further split into subspecies. *Ursus emmonsi*, recently described by Dr. Dall as a 'variety' of *americanus*,* I have not seen. From the description it appears to be a distinct species.

3. The Grizzly bears (including the Barren Ground bear) may be separated into 4 more or less well-marked forms, as follows: (*a*) the true Grizzly, *Ursus horribilis* Ord, from the northern Rocky Mountains; (*b*) the Sonoran Grizzly, 'var. *horriæus*' Baird, probably only a subspecies; (*c*) the Norton Sound, Alaska, Grizzly, probably another subspecies; (*d*) the very distinct Barren Ground bear, *Ursus richardsoni* Mayne Reid. Whether or not the large Grizzly from southern California deserves subspecific separation from the Sonoran animal (*horriæus*) has not been determined.

4. The Sitka bear, *Ursus sitkensis* nob., and the allied Yakutat bear, *Ursus dalli* nob., are the representatives of a very distinct type. They resemble the Grizzlies in the flatness of their skulls, but are much larger, are different in color, have more curved foreclaws, and the Sitka bear has a different type of sectorial tooth. The Yakutat bear is much larger than the Sitka bear and has very different teeth. It may represent an independent section.

5. The Kadiak and Alaska Peninsula bear, *Ursus middendorffi* nob., is the largest of living bears and differs markedly from all other American species. It closely resembles the Great Brown bear of Kamschatka, *Ursus beringiana* Middendorff,† which it only slightly exceeds in size. The extraordinary elevation and narrowness of the forehead suffice to distinguish this bear from all other known species (Pl. IV, fig. 2).

The number of full species of North American bears here recognized is ten: 4 of the Black Bear group; 2 of the Grizzly group; 3 of the big Brown bears of Alaska, and the Polar bear.

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*Science, NS., vol. II, No. 30, p. 87, July 26, 1895.

† *Ursus beringiana* Middendorff, 1851 = *Ursus piscator* Pucheran, 1855. Both are from Kamschatka.

In addition to the splendid series of skulls of big bears in our National Collection and those in my private collection, I have been fortunate in having a number of others loaned me for study. For these I am indebted to the courtesy of Mr. Archibald Rogers, of Hyde Park, N. Y., Mr. W. Hallett Phillips, of Washington, D. C., and Mr. John Fannin, Curator of the Provincial Museum at Victoria, British Columbia. I wish further to express my appreciation of the efforts of Mr. Charles H. Townsend and Mr. J. Stanley-Brown, and also of Mr. Rudolph Neumann, of the Alaska Commercial Company, in securing skulls of big bears from various points in Alaska.

The present paper, which is intended merely as a preliminary announcement of results, to be followed later by a more comprehensive treatise on our bears, is based almost wholly on a study of skulls and teeth. Much additional material is desired, particularly from northern British Columbia and the coast region of Alaska south of the Alaska peninsula.

The external characters—color, length and curvature of claws, length of tail and ears, proportions of feet, and so on—are doubtless of great importance and probably afford many excellent landmarks in differentiating the several species, but unfortunately no series of skins is available for comparison. No museum in the world contains such a series, and any person who will aid in collecting and preserving the necessary material will advance the science of mammalogy. It is known in a general way that the Grizzlies have longer and straighter claws than the big Brown bears of Alaska, and that the animals differ materially in color, but the nature and extent of these differences are unknown.

The Bears present a surprisingly wide range of individual variation in cranial and dental characters, and the sexes differ greatly in size, the males being much the larger and possessing heavier teeth. The material at my command comprises upwards of 200 skulls, covering all known and several previously unrecognized North American species, and has the rare advantage of containing large series from single localities, one such series consisting of no less than 95 skulls. These series show that, in addition to sexual variation and the changes in form and size resulting from difference in age, there is a large range of individual variation in the size, shape, and proportions of the cranium and teeth. They show also that this variation, great as it is, has definite limits beyond which it does not pass, and that excellent and constant characters exist by which the several species and subspecies may be recognized.

Sexual difference in size is most conspicuous in the Grizzlies, though it is marked in the Black bears also. In the latter the disproportion is greater in the teeth than in the skull; in the female the molar teeth are much smaller, narrower, and less massive than in the male.

Individual variation in the teeth is the rule, and the amount of this variation is surprising, affecting the number and relations of the accessory cusps, and also the form and proportions of the fourth upper and lower premolars, and the great posterior 'heel' of the last upper molar.

As is well known, the bears normally have 42 teeth, the dental formula being $i\frac{3}{3}$, $c\frac{1}{1}$, $pm\frac{4}{4}$, $m\ \frac{2}{3}=\frac{20}{22}=42$. The first three premolars above and below, however, are small and nearly functionless, and several of them usually fall out before the animal attains maturity, so that adult skulls rarely contain more than 36 or 38 teeth.

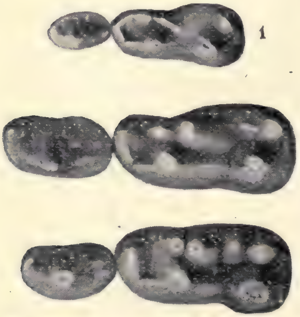

FIG. 6.—Lower carnassial tooth (m_1) and last premolar.

1. Black bear (*Ursus americanus*).
2. Sitka bear (*Ursus sitkensis*).
3. Grizzly bear (*Ursus horribilis*).

In the Grizzlies, Barren Ground, Yakutat, and Kadiak bears the first lower molar (m_1) has one or more cusps or tubercles on the inner side between the middle and posterior cusps (fig. $6,^3$), no trace of which exists in the Black bears (fig. $6,^1$). These intermediary cusps are absent also in the Sitka bear (fig. $6,^2$.) In the Grizzlies and their allies the posterior cusps (inner and outer) are nearly opposite; in the Blacks they are more oblique.

Examination of the molar teeth in several hundred bear skulls shows beyond question not only that the last upper molar decreases in size markedly (and probably rapidly) after the wearing down of the crown has passed a certain plane, but also that the length of the molariform series as a whole in both jaws shortens materially. No gaps are left between the teeth, the wear being compensated by a movement from behind forward which keeps the crowns continually in contact.

KEY TO THE BIG BEARS OF AMERICA.

Molars small and weak; pm ^{4} with inner cusp obsolete or small; m ^{2} without decided heel....... genus THALARCTOS.
  Color, white................................ *Thalarctos maritimus.*

Molars large and powerful; pm ^{4} with inner cusp strongly developed; m ^{2} with enormous heel............ genus URSUS.

Size huge.
  Size largest (skull reaching 440 mm. in greatest length); frontal region enormously elevated above and behind orbits........................ *Ursus middendorffi.*
  Size somewhat smaller (skull less than 425 in greatest length); frontal region nearly flat.
    pm ^{4} very large and quadrituberculate; pm $_4$ large and high without heel; m $_1$ without clear interspace on inner side............. *Ursus dalli.*
    pm ^{4} normal; pm $_4$ moderate, normally with cusp on cingulum in front of main cusp; m $_1$ with clear interspace on inner side..... *Ursus sitkensis.*

Size medium or relatively small.
  Temporal impressions turning in abruptly from postorbital processes, nearly at right angle to cranial axis; skull short........................ *Ursus richardsoni.*
  Temporal impressions not turning in abruptly from postorbital processes; skull longer.
    Frontal elevated and usually convex between postorbital processes..................... *Ursus horribilis.*
    Frontal flattened and concave between postorbital processes......................... *Ursus horriæus.*

Ursus middendorffi sp. nov. Kadiak Bear.

Pl. IV, figs. 2, 3; pl. V, fig. 2; pl. VI, fig. 2.

Type from Kadiak Island, Alaska, No. 54793, ♂ ad., U. S. Nat. Mus., Dept. Agric. coll. Collected July 3, 1893, by B. J. Bretherton. (Original No. 176.)

Characters.—Size huge; largest of living bears, though only slightly larger than *Ursus beringiana* Middendorff, from Kamschatka; frontal region in male enormously elevated, highly arched, and relatively narrow; zygomata bowed outward to an extraordinary degree; postzygomatic part of skull very short.

The bear of Kadiak Island needs comparison with only a single species—*Ursus beringiana*, of Kamschatka. It requires no comparison with the American Grizzlies (*Ursus horribilis* Ord) or with the Barren Ground bear (*Ursus richardsoni* Mayne Reid). Contrasted with the Kamschatka bear the forehead of the male is very much higher, more swollen above and behind the postorbital processes, narrower, and more rounded;

the zygomatic arches are more strongly bowed outward and their posterior roots stand out at nearly a right angle to the cranial axis; the interpterygoid fossa is longer; the ascending arms of the premaxillæ are shorter; the jugal is more extended anteriorly, reaching up in front of the lachrymal foramen [in *beringiana* it falls considerably short of this foramen]. The audital bullæ differ strongly in young skulls of the two species, though they come to resemble one another more in old age. In the young of the Kadiak animal they are very much heavier, more convex inferiorly, and broader at the outer or meatus end. In the adult female the skull is relatively more elongated than in the male, and the frontal region is less elevated.

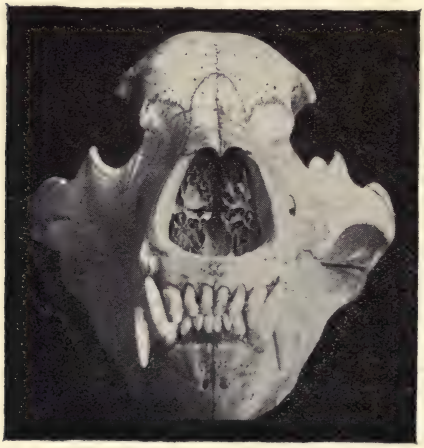

FIG. 7. - Kadiak Bear.
Ursus middendorffi.

The first upper and last lower molars (particularly the latter) are decidedly smaller in the Kadiak animal, while the middle lower molar is nearly the same size in both species. The lower carnassial has strong intermediary cusps or tubercles, as in the Grizzlies.

Measurements of skull of type.—Greatest length of cranium (front of premaxillary to end of occipital crest), 440; greatest basal length (gnathion to occipital condyles), 392; basal length (gnathion to basion), 377; basilar length of Hensel, 370; zygomatic breadth, 277; occipito-sphenoid length (basion to suture between basi- and presphenoid), 105; postpalatal length, 167; basion to plane of front of last upper molar, 238; interorbital breadth, 98; distance between postorbital processes, 132.5; occipito-nasal length, 358; height of brain case above pterygoid, 160; height of brain case above basisphenoid, 123.

Remarks.—Compared with *Ursus beringiana*.* skulls of adult *U. middendorffi* can be distinguished at a glance by the difference in the breadth of the frontal and the degree of elevation of the supraorbital region. Skulls of any age may be distinguished by the peculiarity of the anterior end of the jugal, which in the Kadiak animal reaches upward to articulate with the lachrymal, and also by the smaller size of the first upper and last lower molars. The difference in the posterior ending of the ascending arm of the premaxilla also furnishes a good average character. In the Kadiak bear the premaxillæ rarely reach more than half way up the vertical height of the orbit, while in the Kamschatka animal they usually reach considerably more than half way. The shape of the zygomatic arch as seen from the side differs in the two. In the Kadiak bear it is more highly arched and broader, especially posteriorly. The difference is more marked in the young than in adults.

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* *Ursus arctos* var. *beringiana* Middendorff, Untersuchungen an Schädeln des gemeinen Landbären, p. 74, 1851.

The claws of the fore feet of *Ursus middendorffi* are long and rather strongly decurved on the distal third. Those of the Grizzly (*Ursus horribilis*) are still longer and much straighter. The longest claw of an old male *middendorffi* killed at Kadiak Island, June 18, 1894, and measured for me by Mr. B. J. Bretherton, measured over the convexity of the claw 96 mm., while the distance in a straight line from base to tip on the under side was only 74 mm.

I have named this bear in honor of the celebrated Russian naturalist, Dr. A. Th. von Middendorff, in recognition of his early struggles with the large bears of the shores of Bering Sea. Middendorff named the big bear of Kamschatka *Ursus beringiana*,* and stated that he was particularly struck with a skull from Kadiak which was distinguished by its superior size. It seems fit that the great Kadiak bear, proving distinct from the Kamschatka animal, should perpetuate Middendorff's name. I have examined 16 skulls of this bear.

Ursus dalli sp. nov. Yakutat Bear.

Pl. V, fig. 1; pl. VI, fig. 5.

Type from Yakutat Bay, Alaska, No. 75048, ♂ old, U. S. Nat. Museum, Dept. Agriculture coll. Collected Sept. 8, 1895, by the chief of the Yakutat Indians. (Procured through Albin Johnson. Original No. 2.)

Characters.—Size huge, only slightly less than the Kadiak bear; skull long and massive; frontals rather flat and only slightly elevated above orbits; postorbital processes strongly developed and decurved in old age; paroccipital processes very large and heavy, but relatively short. Molariform teeth large and heavy; pm ^{4} extraordinarily large and high, nearly as broad as long, quadrituberculate (an accessory cusp on inner side in front of postero-internal cusp); m $_1$ much as in the Grizzlies, the inter-

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*[*] *Ursus arctos* var. *beringiana* Middendorff, Untersuchungen an Schädeln des gemeinen Landbären, p. 74, 1851.

space between anterior and posterior parts of tooth on inner side filled by one or more cusplets; m ^{2} large and broad, with heel elongate and broadly rounded posteriorly in male; shorter and more obliquely truncated in female; pm $_4$ large and high, without distinct heel, the main cusp occupying nearly the whole crown of the tooth; a strongly developed peg-like accessory cusp usually present on inner side of main cusp a little behind the middle.

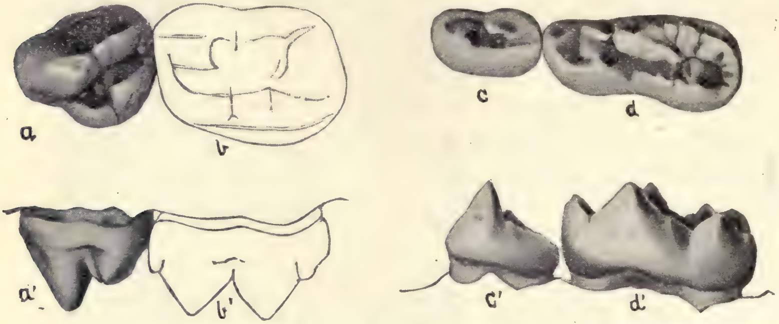

FIG. 8.—Teeth of Yakutat Bear (*Ursus dalli*), natural size.

a. Last upper premolar. *c.* Last lower premolar.
b. First upper molar. *d.* First lower molar.

Measurements of skull of type.—Greatest length of cranium (front of premaxillary to end of occipital crest), 424; greatest basal length (gnathion to occipital condyles), 400; basal length (gnathion to basion), 366; basilar length of Hensel, 360; zygomatic breadth, 269; occipito-sphenoid length (basion to suture between basi- and presphenoid), 107; postpalatal length, 172; basion to plane of front of last upper molar, 242; interorbital breadth, 92; distance between postorbital processes, 134; occipito-nasal length, 360; height of brain case above pterygoid, 148; height of braincase above basisphenoid, 117.

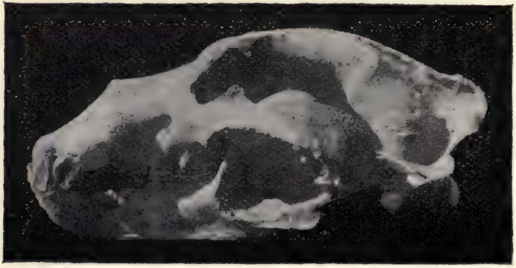

FIG. 9.—Yakutat Bear (*Ursus dalli*).

Remarks.—The Yakutat bear is almost as large as the Great bear of Kadiak and the Alaska peninsula. In fact the total length of the skull from the occipital condyles to front of incisors and the length of the top of the skull (occipito-nasal length) are both slightly greater in *Ursus dalli.* Adult skulls may be distinguished at a glance by the general form, the frontal region of *dalli* being flattened, while that of *middendorffi* is highly arched, and young skulls by the dental characters above mentioned. I have examined five skulls from Yakutat bay.

It gives me pleasure to name this splendid bear in honor of Dr. Wm. H. Dall, whose name must ever be associated with the natural history of Alaska.

Ursus sitkensis sp. nov. Sitka Bear.

Pl. IV, Fig. 1; pl. V, fig. 3.

Type from coast near Sitka, Alaska, No. 6543, Merriam coll. Collected by an Indian; purchased at Sitka and presented to me by Mr. J. Stanley-Brown.

Characters.—Size large, but smaller than *Ursus dalli;* claws long; skull long and heavy, similar to that of *dalli,* but less massive; frontals flat; postorbital processes well developed, but shorter and less decurved than in *dalli;* paroccipital processes much longer and more slender than in *dalli;* incisors, canines, and last premolar large; molars relatively small; pm^4 normal (trituberculate) and very much longer than broad; m_1 with an open interspace on inner side between anterior and posterior cusps (fig. 6^2), much as in subgenus *Euarctos,* thus differing widely from all other big bears of America; m^2 decidedly smaller than in *dalli*; pm_4 with normally a distinct and rather large cusp on cingulum in front and slightly on inner side of main cusp.

Measurements of skull of type.—Greatest length of cranium (front of premaxillary to end of occipital crest), 395; greatest basal length (gnathion to occipital condyles), 345; basal length (gnathion to basion), 329; basilar length of Hensel, 322; zygomatic breadth, 243; occipito-sphenoid length (basion to suture between basi- and presphenoid), 73; postpalatal length, 129; basion to plane of front of last upper molar, 211; interorbital breadth, 85; distance between postorbital processes, 123; occipito-nasal length, 340; height of brain case above pterygoids, 140; height of brain case above basisphenoid, 105.

Remarks.—The Sitka bear resembles the Yakutat bear in general appearance, but is decidedly smaller and differs widely in dental characters. It lacks the excessive development of the last upper premolar which characterizes *Ursus dalli*, and the first lower molar is unique among the large bears, lacking the tubercles that are present in all the others between the anterior and posterior parts of the tooth. In this respect the tooth approaches, though it does not really resemble, that of the Black bears.

A skull purchased from an Indian at Sitka in 1889 by Mr. Charles H. Townsend differs from the other Sitka skulls. It is larger and longer and has decidedly smaller molar teeth. The exact locality where this bear was killed is uncertain, but Mr. Townsend was told that it came from the mainland a little north of Sitka. I have examined 7 skulls of the Sitka bear.

Ursus horribilis Ord. Grizzly Bear.

Pl. IV, fig. 4; pl. V, fig. 4; pl. VI, fig. 1.

Ursus horribilis Ord, Guthrie's Geography, 2d Am. edition, vol. II, pp. 291, 299–300, 1815. [Rhoads' reprint, 1894.] Based on the Grizzly bear of Lewis and Clarke.

Type locality.—Montana.

Geographic distribution.—Northern Rocky Mountains from Wyoming and northern Utah northward; also whole of interior British Columbia and thence northwestward in the interior to Norton Sound, Alaska.

Characters.—Size large (larger than *Ursus richardsoni*, but smaller than any of the Alaska bears); fore claws nearly straight, larger than in any other species, and whitish; hairs elongated over the shoulders, giving almost the effect of a 'hump'; skull and teeth large and massive; frontal region elevated above orbits and highest behind postorbital processes; temporal impressions strongly curved, usually meeting over hinder end of frontals, and not elevated anteriorly to form ridges. Looked at from in front the frontals are normally elevated and convex between the postorbital processes, hiding the sagittal crest (fig. 12), while in the California and Sonora Grizzlies this part of the skull is flattened and depressed, and the temporal ridges and beginning of the sagittal crest may be seen (figs. 11 and 15).

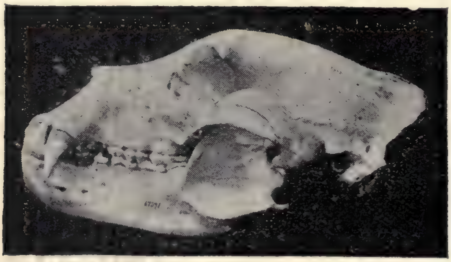

FIG. 10.—Grizzly Bear (*Ursus horribilis*). From Wyoming.

Remarks.—The Norton Sound, Alaska, Grizzly, compared with true *Ursus horribilis* from the Rocky Mountains, differs slightly in cranial and dental characters and will probably merit subspecific separation as *Ursus horribilis alascensis*. It is somewhat larger, the frontal region is furrowed antero-posteriorly between the orbits, the palate averages longer, and the blade of the coronoid process of the mandible is narrower; the first lower molar is broader posteriorly and is much more abruptly and deeply narrowed on the outer side immediately in front of the posterior cusp. Except in a single skull (an old male from the Shaktolik River, No. 76470), the combined length of the basioccipital and basisphenoid along the median line is decidedly less than half the length of the palate. In the Rocky Mountain Grizzly the occipito-sphenoid length is decidedly greater than half the length of the palate.

Ursus horribilis horriæus Baird. Sonora Grizzly.

Pl. IV, fig. 5; pl. V, fig. 6; pl. VI, fig. 4.

Ursus horribilis var. *horriaeus* Baird, Rept. Mexican Boundary Survey, II, Mammals, pp. 24–29, 1859.

Type locality.—Coppermines, southwestern New Mexico.

Geographic distribution.—Southern Rocky Mountains and outlying peaks and ranges in Colorado, New Mexico, Arizona (and probably southern Utah), northern Mexico, and southern California. The type locality is the old Coppermines, near the Rio Mimbres, in Grant Co., New Mex.

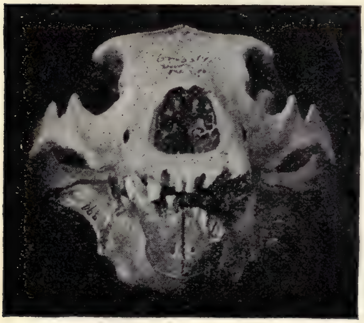

FIG. 11.—Sonora Grizzly from the Coppermines, New Mexico. Baird's type.

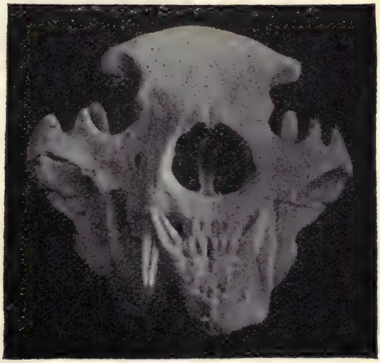

FIG. 12 —Rocky Mountain Grizzly from Wyoming.

Characters.—Size large; skull and teeth large and massive; frontal region not elevated above or behind orbits, highest at, and flattened and concave between, postorbital processes; temporal impressions straight or nearly straight, meeting considerably anterior to hinder end of frontals, and elevated anteriorly to form well-defined ridges or crests (Pl. 6, fig. 4).

Remarks.—Professor Baird in his original description of *horriæus* had three specimens—an adult skin and skull from Nogales, Sonora, and both adult and young skulls from the Coppermines, New Mexico. The adult from the latter locality (No. 990) is here chosen as the type because it is the one used by Baird in his comparisons, and the only one of which he gave a table of measurements. The Nogales skull is higher with reference to its length and differs in other particulars, as shown in the accompanying illustrations (figs. 13 and 14).

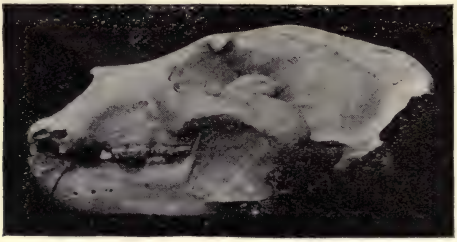

FIG. 13.—Baird's type of *horriæus* from the Coppermines, New Mexico.

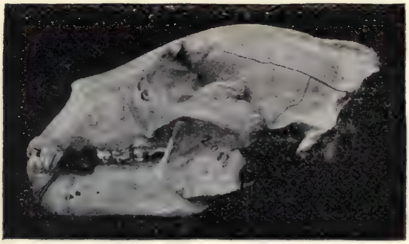

FIG. 14.—Baird's Nogales specimen.

The huge Grizzly of southern California, which unfortunately is rapidly approaching extinction, differs in some respects from the typical Sonora Grizzly and may be entitled to stand as subspecies *californicus.* It is larger, the skull averages longer, and the teeth are of greater size. I have not been able to compare skins of the two forms, but Prof. Baird states that there are color differences; that the Sonora animal lacks the stripes of the California bear, and that the ears and tail are both short and essentially of the same length, while in the California bear the

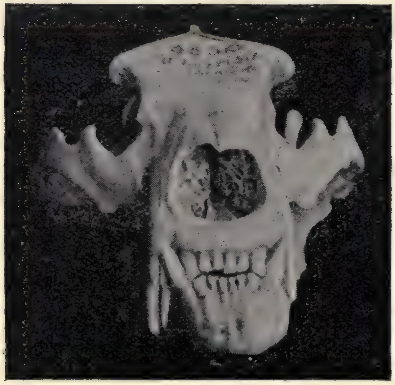

FIG. 15.—California Grizzly from Monterey.

ears are twice as long as the tail. The average basilar length of six skulls from Monterey and old Fort Tejon, California, is 336 mm., while the average of two adult males from New Mexico is only 310. The average of four adult male *horribilis* from the northern Rocky Mountains is 316 mm. But the numbers here averaged are too small to afford reliable results.

Ursus richardsoni Mayne Reid. Barren Ground Bear.

Pl. IV, fig. 6; pl. V, fig. 5; pl. VI, fig. 3.

Ursus richardsonii Mayne Reid, Bruin: The Grand Bear Hunt. London, 1860. Am. ed., pp. 260–261, 1864.

Type locality—Great Slave Lake, Arctic America.

Geographic distribution.—Barren grounds between Hudson Bay and the Mackenzie River.

Characters.—Size smallest of the American big bears; skull short; zygomata broadly spreading; temporal ridges conspicuous and turning abruptly inward from postorbital processes (fig. 17); teeth large and broad. Adult skulls of the Barren Ground bear may be known from all other species by the form of the frontal shield, which is truncated posteriorly by the temporal crests (figs. 16 and 17). The temporal crests, beginning on the posterior edge of the largely developed postorbital processes, run toward the median line, forming nearly a right angle with the cranial axis, as shown in the accompanying illustrations. The postorbital processes are long and peg-like and flattened on top. The sagittal crest is correspondingly elongated, reaching forward beyond the middle of the frontals and measuring more than half as much as the upper surface of the skull. The muzzle is short and

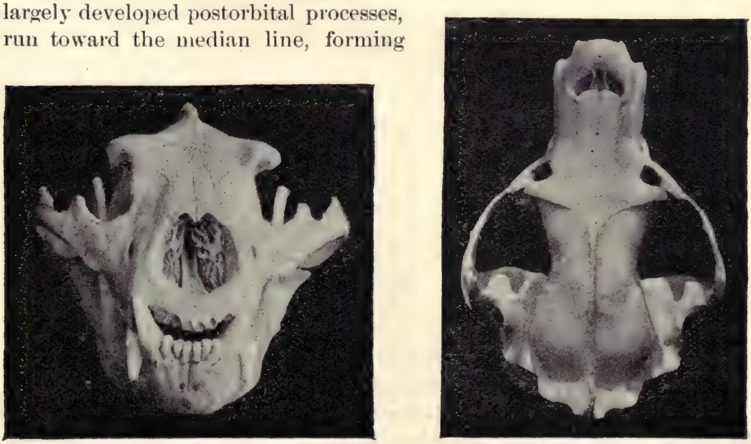

FIG. 16. FIG. 17.

Barren Ground Bear (*Ursus richardsoni*), showing high sagittal crest and abruptly spreading temporal ridges.

slightly upturned, giving the animal a 'pug-nosed' appearance (pl. V, fig. 5). Contrasted with the Grizzlies, the skull as a whole is much shorter and relatively broader, the ratio of zygomatic breadth to basilar length being very much greater. The shortening is chiefly in the brain case, bringing the broad posterior part of the zygomatic arches much nearer the hinder end of the skull. The skull of the young animal is flat on top; that of the adult rises abruptly at the orbits and is convex over the brain case. The angular process of the mandible curves strongly upward at the tip, so that the notch is nearly a complete circle; it is more open in the other bears.

The dentition is distinctly of the Grizzly type. The molars are as large as in the Grizzly. The fourth upper premolar is large and high and has a strong single internal cusp, without accessory cusps in the specimens examined. The fourth lower premolar lacks the antero-internal cusplet of the Grizzlies, and the main cusp slopes back to the posterior margin, where it is rounded off without developing a posterior cusplet. The last upper molar has the inner tubercles flatter than in the Grizzly.

Remarks.—The Barren Ground bear is an excellent species, differing widely from its nearest relative and neighbor, the Grizzly of Alaska, which latter animal is represented in the collection by a number of skulls from the Norton Sound region. All the skulls of the Barren Ground bear I have examined are from the region north of Great Bear Lake, and were collected by R. McFarlane. They are labeled as coming from Anderson River, Franklin Bay, and 'Arctic coast.' Whether the species ranges west of the Mackenzie River I have been unable to ascertain.

The Black Bears. Subgenus *Euarctos* Gray.

The subgenus *Euarctos*, proposed by Gray in 1864* for the common Black bear of North America (*Ursus americanus* Pallas), is well worthy of recognition. It was characterized as follows: "Fur short, uniform. Front claws moderate, not much longer than the hind ones. Hind feet Short. Upper tubercular moderately long, narrowed behind."

In addition to the peculiarities pointed out by Gray, it differs constantly in several excellent dental characters from the large Brown and Grizzly bears of America, and also from *Ursus arctos* Linnæus, of Scandinavia, which is the type of the genus *Ursus*. The most important character, and one which alone is sufficient to warrant the establishment of the subgenus, is the form of the lower carnassial tooth (m_1). This tooth has a broad, open, flat space or step on the inner side between the middle and posterior cusps (metaconid and entoconid), which is never present in the Brown and Grizzly bears (fig. 6). In the restricted genus *Ursus* the metaconid and entoconid are joined together, and the notch between is occupied by one or more accessory cusps. The posterior cusps of the talon (hypoconid and entoconid) are nearly opposite in the Grizzlies and very oblique in the Black bears. The Black bears agree further among themselves and differ from the Grizzlies in the last lower premolar (pm $_4$), which lacks the accessory cusps on the inner side, lacks the median sulcus behind and the inner limiting ridge, and is uniformly much smaller; in the last upper premolar (pm ^{4}), which lacks all traces of the posterior accessory cusp; in the shape of the last upper molar (m ^{2}), which is considerably broadest in the middle and is cut away posteriorly on the outer side, with the heel shorter than in the Grizzlies. In *Euarctos* the coronoid process of the mandible rises at nearly a right angle from the horizontal ramus; in *Ursus* proper by a gradual slope.

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* Proc. Zoöl. Soc. Lond., 692, 1864.

Ursus americanus Pallas. Black Bear.

Ursus americanus Pallas, Spicilegia Zoölogica, fasc. XIV, pp. 5–7, 1780.

Type locality.—Eastern North America.

Geographic distribution.—Forest-covered parts of North America north of the Lower Austral zone.

Characters.—Size small; frontal region usually moderately elevated; zygomata spreading; molar teeth small.

The characters of the subgenus suffice to distinguish *Ursus americanus* from all other American bears except *luteolus* and *floridanus.* From these it differs in the shortness of the skull as a whole, in the smaller size of the molar teeth, and in other particulars pointed out under the latter species.

Measurements of skulls.—Average of 4 adult males from New York State: Basilar length of Hensel, 254; postpalatal length, 118; basion to plane of front m ^{2}, 168; zygomatic breadth, 184; ratio of zygomatic breadth to basilar length, 75.

Ursus luteolus Griffith. Louisiana Bear.

Ursus luteolus Griffith, Carnivorous Animals, pp. 236–237 (with col. pl.), 1821.
Merriam: Proc. Biol. Soc. Wash., VIII, pp. 147–152, Dec. 29, 1893.

Type locality.—Louisiana.

Geographic distribution.—Louisiana and Texas and probably other parts of Austroriparian Zone.

Characters.—Size large; skull long and flat; fronto-parietal region depressed; profile of top of skull (including crest) nearly a straight line; sagittal crest long and high, about half the length of upper side of skull in old age. Contrasted with old skulls of male Black bears from the Adirondacks, in northern New York, the three old male skulls from Mer Rouge, Louisiana, differ uniformly in the following particulars: They are longer and flatter; the occipito-sphenoid length is greater; the distance from foramen magnum to plane of front of last upper molar is greater; the ratio of zygomatic breadth to basilar length is less (average, 64.6 instead of 75 percent); the ratio of postpalatal length to occipito-sphenoid length is considerably greater.

The molars are very large, much larger than in any known species of the Black bear group. The last upper molar in particular is notable for its great breadth as well as length, averaging 29 to 30 mm. in length and 17 mm. in breadth in three old males from Prairie Mer Rouge.

Measurements of skulls.—Skull of type specimen (No. 1155, U. S. Nat. Mus., from Mer Rouge, La.): Greatest length (gnathion to end of occipital crest), 326; basal length (gnathion to basion), 292; basilar length of Hensel, 288; zygomatic breadth, 187; occipito-sphenoid length, 89; postpalatal length, 134; basion to plane of front of last upper molar, 193; interorbital breadth, 68; distance between postorbital processes, 97; occipito-nasal length, 276. Average of three adult males from type locality: Basilar length of Hensel, 280; postpalatal length, 131; basion to plane of front of m^2, 185; zygomatic breadth, 188. Ratio of zygomatic breadth to basilar length, 64.6.

Remarks.—The Louisiana bear resembles the Florida bear in the elongation and narrowness of the skull, but differs in having the frontal region remarkably flattened instead of highly arched, and in having the upper molars much larger.

In my original article on '*The Yellow Bear of Louisiana*'* I made the mistake of referring to this species a bear described by Mr. Arthur Erwin Brown and considered by him to be the *Ursus cinnamomeus* of Audubon and Bachman,† which latter animal is commonly regarded as a color phase of the Black bear. Mr. Brown's bear died in the Philadelphia Zoölogical Garden. It was procured in November, 1891, "at some point on the Union Pacific railway, in Wyoming," "by the late James E. Cooper, a well-known showman of Philadelphia." Mr. Brown afterward kindly sent me the skull for examination (No. 3380 ♂ old, Mus. Phila. Acad. Sci.). To my surprise, it does not belong to either of the two groups of bears inhabiting the United States—the Blacks and Grizzlies—but, in my judgment, is the Carrion bear of the Ural Mountains of Russia, described by Eversmann in 1840 under the name *Ursus cadaverinus.*‡ Although it has short fore claws like the Black bears, as pointed out by Mr. Brown, it does not belong to the subgenus *Euarctos.* The first lower molar is much worn, but instead of the open space or 'step' of the Black bears it shows on both sides the worn-down base of the connecting cusp or tubercle of the large bears, and the last upper molar has the enormous, broadly rounded heel of *Ursus arctos* and its allies. The last upper premolar is exceedingly narrow and the postero-internal cusp is greatly reduced, in which respects it differs from all American bears except the Polar bear, which belongs to another genus.

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* Proc. Biol. Soc. Washington, VIII, 147–152, Dec., 1893.

† Forest and Stream, Dec. 16, 1893, 518-519. Also a subsequent paper in Proc. Acad. Nat. Sci. Phila., June, 1894, 119–129.

‡ Bull. Soc. Imp. Nat. Moscow, 1840, 11–13.

The peculiar cranial characters of Mr. Brown's bear are very well covered by Eversmann's original description. Eversmann states that the skull is thickly built, comparatively short and high, the frontal is arched above the orbits and then slopes abruptly and forms a step with the nasals, which curve up to meet it. The elliptical orbits stand more vertical than in the other species. Eversmann states further that even in the living animal the species can be distinguished. In the Carrion bear the head is short and the prominent forehead does not slope gradually down to the snout, but with an abrupt step. The skin is generally brown, and is lighter on the neck and shoulders, where it is soiled yellow or yellowish brown.

In view of the facts that the early history of Mr. Brown's bear is involved in hopeless obscurity; that the animal differs radically and irreconcilably from all known American species and seems to agree perfectly with the Carrion bear of western Russia, and that numbers of living bears are shipped from western Russia to America for exhibition purposes, it seems more reasonable to regard the specimen in question as an exotic rather than as an American species, of which, up to the year 1896, only a single specimen has come to the notice of naturalists.

Ursus floridanus sp. nov. Everglade Bear.

Type from Key Biscayne, Florida. Skull No. 3484, ♂ old, U. S. National Museum.

Geographic distribution.—The everglades and probably other parts of peninsular Florida.

Characters.—(Type specimen.) Skull very long, high, and narrow; frontal region remarkably elevated, highest immediately behind postorbital processes (more than 100 mm. above hinder part of palate); brain case very long and narrow; interpterygoid fossa very long (71 mm. in type specimen); basisphenoid and palate deeply excavated, the latter strongly arched both antero-posteriorly and transversely.

Measurements of type skull (♂ old).—Basal length (basion to gnathion), 282; basilar length of Hensel (basion to middle incisor), 277; zygomatic breadth, 190; occipito-sphenoid length (basioccipital + basisphenoid), 91; basion to hinder edge of palate, 133; basion to plane of front of last molar, 186; interorbital breadth, 68; distance across postorbital processes, 109; occipito-nasal length, 290; greatest length of skull, 330; ratio of zygomatic breadth to basilar length, 68.5.

Remarks.—The bear of the everglades seems to differ specifically from both the common Black bear of the eastern United States (*Ursus americanus* Pallas) and the Louisiana bear (*Ursus luteolus* Griffith). I have not had an opportunity to compare the skin of the Florida bear with that of other species, but have examined several skulls. The cranial characters are marked, particularly in the adult male. The skull resembles that of the Louisiana bear in great length and narrowness, but differs in the form of the palate and vault of the cranium. The frontal region is highly arched, while that of the Louisiana bear is flattened, and the molar teeth are much smaller than in *luteolus.*

Ursus emmonsi Dall. Glacier Bear.

Ursus americanus var. *emmonsii* Dall, Science, NS., II, No. 30, p. 87, July 26, 1895.

Type locality.—St. Elias Alps, Alaska (near Yakutat Bay).

Geographic distribution.—Glacier region of the St. Elias Alps and thence southeasterly along the mountains to the neighborhood of Juneau; limits of range unknown.

Characters.—Size small; claws short and strongly curved; skull not seen; pelage peculiar: "The general color of the animal resembles that of a Silver fox. The fur is not very long, but remarkably soft and with a rich under fur of a bluish black shade, numbers of the longer hairs being white or having the distal half white and the basal part slaty. The dorsal line from the tip of the nose to the rump, the back of the very short ears, and the outer faces of the limbs are jet black. Numerous long white hairs issue from the ears; black and silver is the prevalent pelage of the sides, neck and rump; the under surface of the belly and the sinuses behind the limbs are grayish white, or even nearly pure white, I am told, in some cases. The sides of the muzzle and the lower anterior part of the cheeks are of a bright tan color, a character I have not seen in any other American bear; and this character is said to be invariable. There is no tint of brown elsewhere in the pelage. There is no tail visible on the pelts. The claws are small, very much curved, sharp, black above and lighter below; the animal evidently can climb trees, which the Brown bear cannot do."*

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* Dall: Science, July 26, 1895, p. 87.

EXPLANATION OF PLATES.

PLATE IV.

Fig. 1. *Ursus sitkensis* ♂ ad. Mainland north of Sitka. Coll. C. H. Townsend.
2. *Ursus middendorffi* ♂ yg. ad. Kadiak Island, Alaska. No. 67401, U. S. Nat. Mus.
3. *Ursus middendorffi* ♂ old. Kadiak Island, Alaska. No. 55493, U. S. Nat. Mus.
4. *Ursus horribilis* ♂ ad. Bighorn Mountains, Wyoming. No 67391, U. S. Nat. Mus.
5. *Ursus horriæus* ♂ old. Coppermines, New Mexico. No. 990, U. S. Nat. Mus.
6. *Ursus richardsoni* ♂ old. Anderson River. No. 6255, U. S. Nat. Mus.

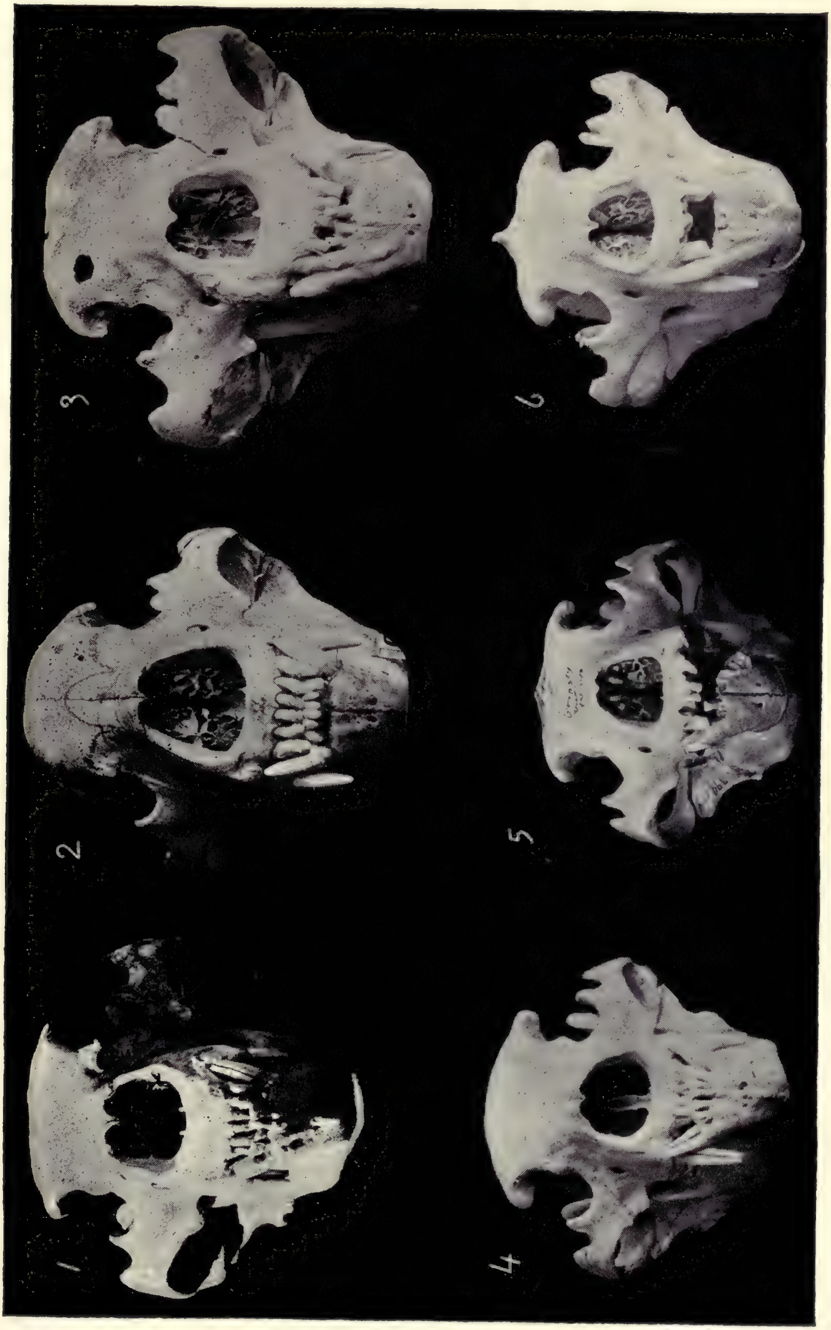
PLATE V.

Fig. 1. *Ursus dalli* ♂ old. Yakutat, Alaska. No. 75048, U. S. Nat. Mus.
2. *Ursus middendorffi* ♂ yg. ad. Kadiak Island, Alaska. No. 67401, U. S. Nat. Mus.
3. *Ursus sitkensis* ♂ ad. Sitka, Alaska. No. 6543, Merriam Coll.
4. *Ursus horribilis* ♂ ad. Bighorn Mountains, Wyoming. No. 67391, U. S. Nat. Mus.
5. *Ursus richardsoni* ♂ old. Anderson River. No. 6255, U. S. Nat. Mus.
6. *Ursus horriæus* ♂ old. Coppermines, New Mexico. No. 990, U. S. Nat. Mus.

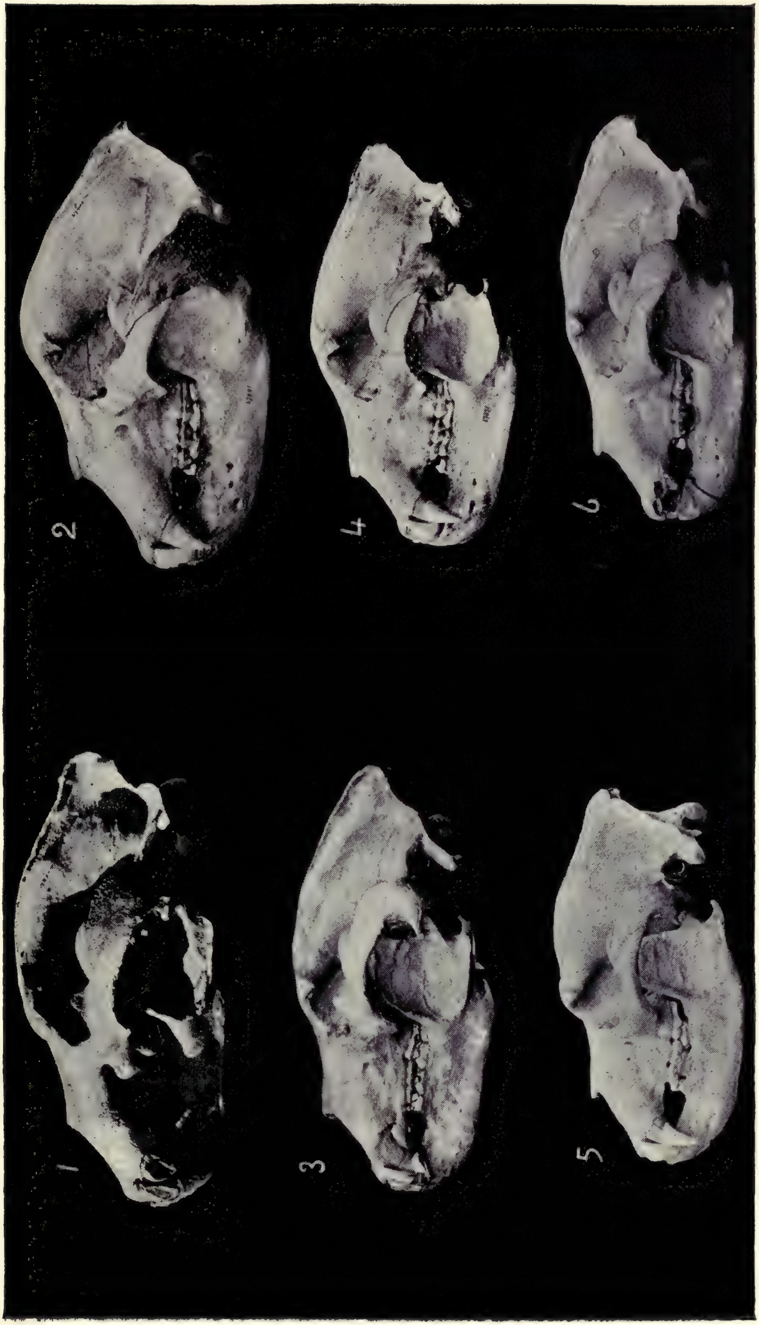
PLATE VI.

Fig. 1. *Ursus horribilis* ♂ ad. Bighorn Mountains, Wyoming. No. 67391, U. S. Nat. Mus.
2. *Ursus middendorffi* ♂ old. Kadiak Island, Alaska. No. 55493, U. S. Nat. Mus.
3. *Ursus richardsoni* ♂ ad. Anderson River. No. 6255, U. S. Nat. Mus.
4. *Ursus horriæus* ♂ old. Coppermines, New Mexico. No. 990, U. S. Nat. Mus.
5. *Ursus dalli* ♂ old. Yakutat, Alaska. No. 75048, U. S. Nat. Mus.

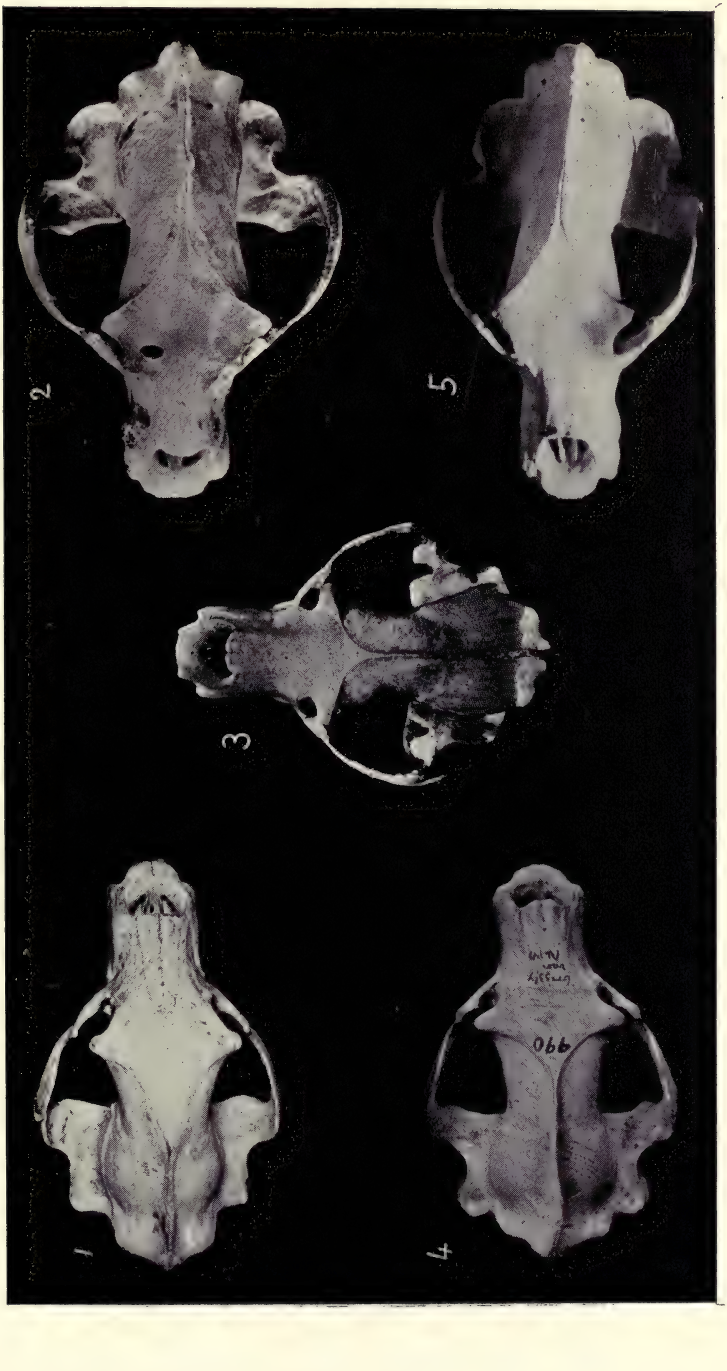
[NOTE.—The photographs from which the accompanying illustrations were made belong to the Division of Ornithology and Mammalogy of the U. S. Department of Agriculture. They are here used by courtesy of Dr. Charles W. Dabney, Jr., Assistant Secretary of Agriculture.]



1 *Ursus sitkensis* ♂ ad. 2 *U. middendorffi* ♂ yg. ad. 3 *U. middendorffi* ♂ old. 4 *U. horribilis* ♂ ad. 5 *U. horriæus* ♂ old. 6 *U. richardsoni* ♂ ad.



1 *Ursus dalli* ♂ old. 2 *U. middendorffi* ♂ yg. ad. 3 *U. sitkensis* ♂ ad. 4 *U. horribilis* ♂ ad. 5 *U. richardsoni* ♂ ad. 6 *U. horriæus* ♂ old.



1 *Ursus horribilis* ♂ 2 *U. middendorffi* ♂ 3 *U. richardsoni* ♂ *U. horriæus* ♂ 5 *U. dalli* ♂

VOL. X, PP. 85-92 MAY 26, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

THE PURPLE-FLOWERED, STEMLESS VIOLETS OF THE ATLANTIC COAST.*

BY CHARLES LOUIS POLLARD.

The acaulescent species of the genus *Viola* constitute a most perplexing natural group, and are very baffling to one who attempts, as I have attempted during the last five years, to discover satisfactory and constant characters on which to base a specific arrangement. While herbarium specimens of these plants are quite adequate for morphological study, it has been found that habit and habitat are of the utmost importance in respect to specific relationship, as is also the degree of variation under changed conditions of environment. I have therefore supplemented a close and searching series of field observations during the past few seasons by a study of many different forms under cultivation, noting the behavior, for example, of two plants from the same patch, one grown in sandy soil, with full exposure to the sun, and the other in damp, rich soil in a shaded situation. A residence of several successive seasons in one neighborhood afforded an opportunity of observing whether a given specimen set out in one summer presented marked leaf variation in the next.

The result of these investigations proves, I think, conclusively, that while several of these violets are extremely polymorphous, the species themselves do not intergrade to the extent generally believed. The difficulty has arisen in some cases by a confusion of the earlier types by writers at the beginning of this century;

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* Read before a meeting of the Society held May 2, 1896.

in other instances it is due to an over-conservative view of what constitutes a species. It is a well-known fact in botany, and I presume also in other branches of biology, that the species of one genus differ *inter se* to a much less extent than those of another genus. In *Lechea*, for example, we are forced to depend almost solely on the appearance and structure of the radical shoots springing up after the close of the flowering season, while in the nearly allied genus *Polygala*, we have usually not only well-marked floral characters, but habit and leaf arrangment to guide us in making determinations. I believe that wholesale reduction to a single species of a number of so-called polymorphous types is a most unphilosophical and evasive method of treatment and productive of immense difficulty to the critical monographer. As an illustration of the simple solution presented when one of these aggregate types is reduced to its component forms, I may refer to the two Eastern species of *Sanicula*, which for many years were sources of despair to most botanists, since they presented remarkable variability in habit and phyllotaxy. Mr. E. P. Bicknell, after an extended series of field observations, discovered that there were altogether four very distinct species confused under the two originals, affording not only constant characters with respect to habit of growth and geographical range, but also in the fruit, which is of paramount importance in the study of all Umbelliferæ.* The same author has recently shed light on the Eastern forms of *Sisyrinchium*, no satisfactory disposal of which has heretofore been accomplished.† A similar condition exists among the violets of the Atlantic coast, and, while I by no means wish to imply that we can obtain an absolutely correct systematic treatment of this or any other genus, I do contend that it is possible to so arrange the species that any given plant may be determined with comparative ease. The conspectus of the group, which will be found at the close of this paper, is merely tentative, and is offered simply as the outgrowth of the field and herbarium study already referred to.

In taking up the discussion of individual species I wish to embrace the opportunity of extending thanks to Dr. N. L. Britton, of New York, for the loan of numerous specimens from the Columbia University herbarium, and also to Messrs. H. W. Olds and D. Leroy Topping, of Washington, for abundant field-notes and living plants.

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* Bull. Torr. Club, 22, 351–361, 1895.

† Ibid., 23, 130–137, 1896.

Passing over for the present the consideration of the Linnæan species, *Viola pedata*, which differs in root-structure from the other members of the group, we shall find that *V. palmata*, also described by Linnæus, may be fairly regarded as the type of its class, since it is the aggregate from which most of the remaining species have been separated. With *sagittata* and possibly *dentata*, *V. palmata* constitutes what we may call the heterophyllous type of stemless violets, or those in which the earliest leaves differ in shape from the later appearing ones. In *palmata* only the first two or three leaves, which are cordate in outline and rather small, are entire, the remainder being usually lobed to a greater or less extent. In the majority of forms there are three main divisions, of which the central one is the largest, the lateral lobes being occasionally cut-toothed or still more deeply divided. The general contour of the leaf is ovate or oblong, the length somewhat exceeding the breadth, the base never cucullate or inrolled as in *obliqua*, our common round-leaved violet. With a view to ascertaining how closely these two species might approach each other in leaf-forms, I set out several specimens in close proximity one fall. The following summer the leaves of *palmata* were scarcely at all lobed, but they preserved their characteristic outline, and were quite clearly distinguishable from the allied species. Similar observations have been made by others who have had the plants under cultivation. But this is not the only distinguishing character of *V. palmata*; it grows almost invariably in rich, shaded woodlands, and, as Schweinitz has observed,* never occurs in swamps or bogs, where *obliqua* is most common. Dr. Gray once reduced *palmata* to varietal rank in the fifth edition of the Manual,† but he afterward restored it to its former place,‡ a conclusion in which every other botanist of the century has concurred. The species of Muhlenberg and Schweinitz here referred to *palmata* are merely forms exhibiting slightly unusual degrees of lobation. Le Conte's *V. septemloba*, however, belongs to a different category. It is apparently confined to brackish meadows along the coast from Staten Island to the Gulf States, and I had always considered it a good illustration of varietal differences induced by local influences, but on a recent excursion with Dr. Britton to the home of the plant I became thoroughly convinced as to its specific validity. The leaves are quite glabrous and succulent, chiefly remarkable for the constancy exhibited in the shape of their lobes, which in every one of the numerous plants examined consisted of a large central lobe and three lateral pairs, having a pinnate instead of a palmate arrangement, the large lobe serving as a rachis. Minor characters are presented also in the shape of the rootstock.

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*Am. Journn. Sci., 5, 54, 1822. †Gray, Man. Ed., 5, 78, 1867.

‡Coult., Bot. Gaz., 11, 254, 1886.

Our commonest violet has passed under a very varied assortment of names. In Hill's Hortus Kewensis *Viola obliqua* is first described and so well figured as to leave not the slightest doubt concerning the plant to which it refers.* Twenty years later Aiton in a similar work describes *V. obliqua* and *V. cucullata*, assigning the former name to a plant with pale flowers ("petala straminea"), which may have been an albino of the same species, or else something quite distinct.† At all events, Aiton's *cucullata* is Hill's *obliqua*, and the former name, though promulgated twenty years later, has been accepted by all our botanists up to the present time, *obliqua*, if retained at all, being based on Aiton's and not on Hill's plant. Dr. Gray admits the applicability of the name *obliqua* to our common violet in his revision of the genus published in the Botanical Gazette for 1886,‡ where he says "The name *cucullata* would have to give way to the much earlier-published *V. obliqua* Hill, well figured and unmistakable in his Hortus Kewensis." The calamity that would attend the taking up of an older name Dr. Gray averted by retaining the plant in question as a variety of *palmata*. The characters have been chiefly pointed out in connection with the latter; it only remains to say that *obliqua* has the earlier leaves reniform, the later ones cordate and cucullate, usually glabrate or subpubescent, and grows in wet or damp situations.

The history of Walter's *V. villosa* affords a further illustration of the differences in opinion between early and late botanists. Before 1850 it was recognized as a good species in nearly every published work, including the monographs of Schweinitz and Le Conte, Nuttall's Genera, and Torrey and Gray's Flora. It is not mentioned in the first edition of Gray's Manual, but is treated as a species in the second and third editions of the same work, and depressed to varietal rank in the fifth, under the name of *cordata*. In the first fascicle of the Synoptical Flora of North America, part I, Dr. Robinson transfers this variety to *palmata*, applying to it the original specific name *villosa*, to which he appends the abbreviation "n. var." It is certainly one of the marvels of systematic botany that a plant described by Walter in 1788 as *Viola villosa* should be able to reappear, first as *V. cucullata* var. *cordata* in 1867, and then as *V. palmata* var. *villosa*, "n. var." in 1895!

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* Hill, Hort. Kew., 316, t. 12, 1769. † Aiton, Hort. Kew., 3, 288, 1789.

‡ Coult. Bot. Gaz., l. c.

The species has an early blooming period, and may be found on dry hillsides, usually in rich soil, always distinguishable on account of its leaves, which are round-cordate, almost orbicular in outline, and lie closely impressed on the ground; they are variegated with purple veins beneath, and exhibit a delicate, silvery pubescence. The flowers are rather small, reddish-purple in hue, and the plant sends up but few leaves and flowers from a simple rootstock.

Viola sagittata, another of Aiton's species, has received universal acceptance, but it has also been made to include some forms for which we can find no warrant in the original description. The leaves are there referred to as "unequally and remotely serrate, incised-sinuate below the middle, subpubescent, cordate-sagittate, oblong."* This seems sufficiently clear for all practical purposes, and yet in one of our botanical text-books *V. sagittata* is described as follows: "Smoothish or hairy; leaves on short and margined, or the later often on long and naked petioles, varying from oblong-heart-shaped to halberd-shaped, arrow-shaped, oblong-lanceolate or ovate, denticulate, sometimes cut-toothed near the base."

Such a description is not merely faulty but false. The author of the species states distinctly that the leaves are "incised-sinuate below the middle;" yet when a student learns that they are "sometimes cut-toothed near the base," as stated above, he is apt to mistake type for variation, gaining, accordingly, an incorrect conception of the species; and this is precisely what has happened in the case of *V. sagittata*. The plant which Aiton had in mind is far less common than is generally supposed. It has rather obtuse sagittate or hastate glabrous leaves, which although at first borne on petioles scarcely exceeding the scapes, soon become greatly elongated, the petiole attaining a length of twice or thrice that of the blade, the base of which is always sharply dentate or deeply incised. Even at the early vernal stage the smooth leaf with its peculiar base serves to differentiate the plant from *V. ovata* Nutt., with which it is always confounded. Both species have the first three or four leaves oval and entire or merely crenate, but before flowering, *V. ovata* puts forth its characteristic strongly pubescent or even villous foliage, the regularly shaped, almost entire, ovate-elliptical leaves never becoming so elongated as to exceed either flowering or fruiting scape.

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*A literal translation. See Aiton, l. c.

Viola ovata Nuttall is *V. ciliata* of Muhlenberg's Catalogue,* well described and differentiated afterward by Darlington and other writers and retained by Torrey and Gray as a variety of *sagittata.* The plant which I last year described as another variety of *sagittata*, under the name of *Hicksii*, † is much closer to *ovata* than to the true *sagittata* as now understood, and I take this opportunity of indicating its transfer, retaining it under the varietal name. Dr. Robinson, in the Synoptical Flora above quoted, ‡ remarks in connection with this form that the recurved fruiting peduncles and distinctly mottled seeds "are not infrequently associated with quite different foliage." However this may be, specimens have been sent to Prof. C. F. Wheeler, of Michigan, and to Dr. T. J. W. Burgess, of Canada, both of whom have admitted it to be distinct from what they are accustomed to regard as typical *sagittata.* We have it in the National Herbarium from Pennsylvania and from Sussex county, New Jersey, in addition to the original locality near Pierce's Mill, in the District of Columbia.

Pursh's *Viola dentata*, here reinstated, is a plant to which my attention was called by Dr. Britton some time ago as a species of marked validity. The leaves in this plant are glabrous and somewhat flaccid, deltoid-cordate, or even panduriform in outline, irregularly crenate, and in general so unlike those of the ordinary violets with which it is associated that it has been considered a hybrid. Le Conte pointed out these characters, under his name of *emarginata*, sixteen years after Pursh's original publication. The plant is mainly of southern range. A typical specimen of it, collected by Dr. John K. Small in northern Georgia in 1895, is to be found in the herbarium of Columbia University. In the National Herbarium the species is represented by a plant found in the District of Columbia by Dr. Vasey.

It will be observed that eight species of the eastern acaulescent purple-flowered violets are here maintained as distinct. Pursh and Schweinitz, two of the earliest authorities in this century, recognized each ten species, Nuttall accepted six, Le Conte thirteen, and Torrey and Gray six. In the first edition of the Manual, Gray admits but four species, in the second five. and in the fifth and sixth editions three only. In the most recently published work, the Synoptical Flora, above referred to, there are included three species and four varieties. It seems obvious that the most logical course of procedure for a conservative botanist is the reduction of all possible forms to the Linnæan species *palmata*, for the differences between *palmata* and *sagittata*, the validity of both of which is everywhere admitted, are scarcely more than those between any others of this group selected for comparison.

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* Muhl. Cat., 26, 1813, without synonymy or description.

† Coult. Bot. Gaz., 20 : 326, 1895.

‡ I, 1 : 197, foot-note.

SYNOPSIS OF SPECIES.*

Leaves all pedately divided; rootstock short and abruptly perpendicular	*V. pedata.*
Leaves broadly lobed or undivided; rootstock ascending or horizontal.	
Plants glabrous or with very slight pubescence:	
Leaves somewhat pinnately 7-lobed	*V. septemloba.*
Leaves deltoid-cordate or panduriform	*V. dentata.*
Leaves hastate or sagittate, basally incised	*V. sagittata.*
Leaves cordate-cucullate	*V. obliqua.*
Plants pubescent or villous:	
Leaves palmately lobed	*V. palmata.*
Leaves ovate or oval	*V. ovata.*
Leaves cordate-orbicular	*V. villosa.*

Viola pedata L., Sp. Pl. 933, 1753.† Not of subsequent authors.

V. pedata bicolor Pursh, fide Raf. in D. C., Prodr. 1 : 291, 1824.

Viola pedata inornata Greene, Pitt. 3 : 35, 1896.

V. pedata of authors, not of L.

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* In this connection it should be stated that *V. pedatifida* Don, which is closely related to *V. pedata*, is omitted as not belonging strictly to our coast.

† Prof. E. L. Greene has proved that the type of the Linnæan *pedata* must have been a plant of the bicolor variety rather than the monocolored form which we are accustomed to regard as *pedata*. This is conclusively shown by an examination of the plate of Plukenet to which Linnæus refers.

Viola palmata L., Sp. Pl. 933, 1753.

Viola heterophylla Muhl., Cat. 25, 1813.
Viola palmata var. *d. heterophylla* Ell., Bot. S. C. and Ga., 1 : 300, 1817.
Viola triloba Schwein., Am. Journ. Sci., 5 : 57, 1822, in part.
Viola cucullata var. *palmata* A. Gray, Man. Ed., 5 : 78, 1867.

Viola septemloba Le Conte, Ann. N. Y. Lyc., 2 : 141, 1828.

Viola obliqua Hill, Hort. Kew., 316, t. 12, 1769. Not Pursh, 1812.

Viola cucullata Ait., Hort. Kew., 3 : 288, 1789, in part.
Viola asarifolia Pursh, Fl. Am., Sept. Suppl., 732, 1812, in part.
Viola papilionacea Pursh, Fl. Am., Sept., 1 : 173, 1812, in part.
Viola affinis Le Conte, Ann. N. Y. Lyc., 2 : 138, 1828, in part.
Viola congener Le Conte, Ann. N. Y. Lyc., 2 : 140, 1828, in part.
Viola palmata var. *cucullata* A. Gray, Coult. Bot. Gaz., 11 : 254, 1886.
Viola palmata var. *obliqua* A. S. Hitchc., Trans. St. Louis Acad., 5 : 487, 1891.

Viola villosa Walt., Fl. Car., 219, 1788.

Viola sororia Willd., Hort. Berol., 1 : 72, 1809.
Viola villosa var. *b. cordifolia* Nutt., Gen. 148, 1818, in part.
Viola cucullata var. *cordata* A. Gray, Man. Ed., 5 : 78, 1867.
Viola palmata villosa Robinson, Syn. Fl. N. Am., I, 1 : 196, 1895.

Viola dentata Pursh, Fl. Am., Sept., 1 : 172, 1812.

Viola sagittata var. *b. emarginata* Nutt., Gen. 148, 1818.
Viola emarginata Le Conte, Ann. N. Y. Lyc., 2 : 142, 1828.

Viola sagittata Ait., Hort. Kew., 3 : 287, 1789.

Viola ovata Nutt., Gen. 148, 1818.

Viola primulifolia Pursh, Fl. Am., Sept., 1 : 173, 1812, not *V. primulæfolia* L., 1753.
Viola ciliata Muhl., Cat. 26, 1813, without description or synonymy.
Viola sagittata var. *b. ovata* T. and G., Fl. N. Am., 1 : 138, 1838.

Viola ovata Hicksii Pollard.

Viola sagittata Hicksii Pollard, Coult. Bot. Gaz., 20 : 326, 1895.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

LIST OF MAMMALS OF THE DISTRICT OF COLUMBIA.

BY VERNON BAILEY.

Useful lists of the plants and birds of the District of Columbia have long since been published, but no list of the mammals of the District has as yet appeared. Some species are known to have become locally extinct, and it is probable that others, of which we have no record, have vanished since the settlement of the country. The present list, imperfect as it is, may serve as a nucleus around which to gather additional data, and may prove useful as a guide in determining the changes that are constantly taking place in the relative abundance of species. Corrections and additional notes, with as exact data as possible, are requested.

To limit the list to species occurring within the present boundary of the District would throw out some that a few years ago were common where the city of Washington now stands; but by following the botanists and ornithologists in the use of a circular area with a radius of 20 miles and the Capitol as a center, all of the local species may be included. Probably this circle could be narrowed to half its diameter without leaving out a species.

In preparing this list my own observations have been supplemented by field-notes kindly placed at my disposal by several mammalogists who have done more or less field-work in the vicinity of Washington, mainly during the past 10 years. Each note is referred in the text to its proper authority; but I wish to express my thanks to Mr. Morris M. Green, Dr. C. Hart Merriam, Dr. A. K. Fisher, and Mr. E. A. Preble for assistance. During the years 1888 and 1889 Mr. Green collected 18 species of mammals within a mile or two of the city. I do not know of a larger list of species taken in the District by one person.

As my own acquaintance with the bats of the District has been limited to early spring and late fall, most of the notes on this group are borrowed. Through the kindness of Mr. F. W. True I am able to include 2 species of bats from National Museum specimens collected in the prescribed area.

In regard to the larger mammals known to have once inhabited the region, but at present locally extinct, much valuable data is available; but for the present paper a brief list of extinct species will suffice. The following 7 species have disappeared from the region since the coming of white men: *Ursus americanus*, *Canis nubilis*, *Felis concolor*, *Castor canadensis*, *Cervus canadensis*, *Bison bison*, *Mus rattus*. The last-named species was introduced and then disappeared before its rival, *Mus decumanus.*

The following 38 species are known to occur at the present time within 20 miles from the Capitol and most of them within the District limits:

Didelphis virginianus. Opossums are common in the woods around Washington, where their tracks may be seen on the banks of every creek and pond. The stupid animals even wander into the city. In the spring of 1894 I found one sleeping on the branch of a tree near Connecticut Avenue, on the hill east of Rock Creek.

Sciuropterus volans. Flying Squirrels have been found in the woods on all sides of the city. Though strictly nocturnal and rarely seen, except when driven from their nests in hollow trees or caught in traps set over night on logs or stumps in the woods, they are not rare. In 1888 and 1889 Mr. Green found several pairs living in woodpecker holes in the trees along Rock Creek and others in the woods near the Soldiers' Home and along the Eastern Branch. Mr. Preble found them rather common at Mt. Vernon, where he secured 8 specimens one day by pounding on hollow trees and shooting the squirrels as they ran out of the holes. One was caught in a trap I had set for wood rats near the west end of Chain Bridge. But for the numerous cats that run wild in the woods, and to which flying squirrels fall an easy prey, these soft-furred, big-eyed, gentle little beauties would be much more common.

Sciurus hudsonicus. Red Squirrels are frequently seen among the trees in the Zoölogical Park, where they show their appreciation of the protection there offered by becoming unusually tame and unsuspicious. They cross Rock Creek and follow the trees to the top of the hill above High Bridge. In Woodley Park they are less frequently seen; in fact, the only one I saw there during the past winter had been shot and then shaken by a dog and left lying in the path with his bright winter coat torn and soiled. On the west side of the Potomac red squirrels live along the steep, wooded bluffs, but are so shy that lately while running a line of traps among the rocks I did not see a live one. A few low *chr-r-r-r-s* were heard, chestnut shells were found on logs and rocks, and one unfortunate squirrel got his neck in a trap I had set under the rocks for a *Neotoma*. Mr. Preble tells me they are common at Marshall Hall, and I have several times heard them in the swamps near Hyattsville.

Sciurus carolinensis. Gray Squirrels range up to the edge of the city wherever there is timber, and sometimes wander into the city parks. Mr. Preble saw one in the Smithsonian grounds in 1894. I have seen them back of Mt. Pleasant and on the east side of Rock Creek, just above Connecticut Avenue bridge. They are not uncommon throughout the extensive forest area of the Zoölogical, Rock Creek, and Woodley parks. In the grounds of the Soldiers' Home they are abundant and unusually tame. They are common at Mt. Vernon and Marshall Hall and along the Virginia side of the Potomac above Georgetown, but except in the parks where protected from hunters they are exceedingly shy and rarely seen. The extensive areas of native forest, with old hollow walnut, butternut, hickory, chestnut, beech, and oak trees, offer a paradise of safe retreats and abundant food for squirrels, and as long as these forest areas remain, so will the furry-coats.

Sciurus cinereus. Fox Squirrels are not common in the immediate vicinity of Washington, but many are shipped to Center Market from points in Virginia 30 or 40 miles west of the city, and in Dr. Merriam's collection are several specimens from Laurel, Md.

Tamias striatus. Chipmunks are scarce in the immediate vicinity of the city, probably owing to the cats, dogs, and boys. I have seen a few in the Zoölogical Park and the Soldiers' Home grounds, and lately caught one and heard others on the west side of the Potomac, above Chain Bridge. Mr. Preble has found them rather common at Mt. Vernon. Dr. Fisher reports them from Munson Hill and Arlington, Va.; Sligo, Piney Branch, Silver Springs, and Sandy Springs, Md.

Arctomys monax. Woodchucks are still common on both sides of the Potomac River above Chain Bridge and on High Island and the little island just above, to which Dr. Merriam has given the appropriate name 'Woodchuck Island.' Six or seven years ago Dr. Fisher found them a couple of miles lower down on the cliffs on the west side of the river below Chain Bridge and on the flats on the east side between the river and canal. I have lately taken several on High Island and on the west side of the river opposite. Most of the burrows are located among rocks on the islands and on the steep slopes and cliffs of the river hills. On High Island there are several old breeding dens, regular strongholds, between and under the rocks. Woodchucks are said to be more common farther up the river, and I was told of a place where one lives near the east end of Chain Bridge.

Mus musculus. House Mice are numerous throughout the city and about buildings in the surrounding country. Some have taken up their residence in the woods and fields and along old fences and stone walls.

I have frequently caught them along Rock Creek in traps set for white-footed mice, and Mr. Preble has caught a number on the Potomac flats below the city. That they are common outside of buildings is further proved by the presence of their skulls in owl pellets. In 675 pellets of barn owls taken in the Smithsonian tower Dr. Fisher found 452 skulls of *Mus musculus.**

Mus decumanus. The common Brown Rats are numerous in the city and in the scattered buildings of the surrounding country. They show less inclination to take to the woods than do the house mice, *M. musculus.* I have not found them at any considerable distance from buildings, but in the previously mentioned 675 pellets of barn owls taken from the Smithsonian tower were 134 skulls of this species.*

Peromyscus leucopus. The White-footed Mice are common throughout the woods in every part of the District. They are abundant along Rock Creek near the Massachusetts Avenue and Connecticut Avenue bridges, and on the west side of the Potomac and east side of Anacostia River. I caught one in a trap at a hole in a stone wall near Rock Creek, and the next night caught a house mouse at the same hole. I have also taken them at the same holes where *Blarina brevicauda*, *Microtus pennsylvanicus*, and *M. pinetorum* were caught on the preceding or following nights, and many of my specimens have been eaten in the traps by blarinas that visited the traps before me.

Neotoma pennsylvanica. Wood Rats are fairly common among the rocks on the west side of the Potomac River a mile above Chain Bridge, and it is probable that they occur all along the river cliffs up to the Blue Ridge. No doubt they extend down to the end of the rocky bluff opposite Georgetown, or did before extensive quarrying disturbed their homes. They are rock-dwellers, and will probably not be found near the District away from the river cliffs. None have been taken on the east side of the Potomac.

Fiber zibethicus. Muskrats are common in all suitable localities near Washington. They are especially numerous along Rock Creek, where they have increased rapidly since receiving the protection of the Zoölogical Park. In favorite places the creek banks are perforated with their burrows, plants cut for food are strewn along the shores, and the animals may be seen swimming about in broad daylight. It will be interesting to see how far this increase will go and by what circumstances it will be limited. On the big marsh extending along both sides of Anacostia River muskrat houses are common, and a few may be seen in the ponds and marshes on the west side of the Potomac. Tracks and burrows are common along Beaver Dam Branch, on the east side of Anacostia River, and still more common along the arm of the Potomac that flows around the east side of High Island. Large numbers of skins are brought to market by negro trappers from lower down the river.

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*Science, N. S., III, p. 623, April 24, 1896.

Microtus pennsylvanicus. Meadow Mice are probably the most abundant mammals of the District. They press into the edge of the city on all sides and even into the parks and grassy vacant lots. Several have been caught in the Department of Agriculture grounds. Mr. Preble has caught a large number on the Potomac flats, and I have myself taken fully 100 close to the edges of the city. They are numerous along the Rock Creek flats from Massachusetts Avenue bridge up through the Zoölogical Park and fairly swarm along the Potomac and Anacostia marshes. They also range to the tops of the highest hills wherever a heavy growth of grass furnishes a good supply of food and sufficient cover for their runways. A few are found in the woods, especially along the edges of creeks, but open country, marshes, and grassy bottom lands are their favorite haunts.

Microtus pinetorum. Pine Mice are common, but less so and less frequently taken than the meadow mice, which often occupy the same ground. The generalization may be made (but it will not always hold) that the meadow mice live in the fields, meadows, and open country, while the pine mice live in the woods and brush. The pine mice are frequently caught in old fields and on open bottom land, but are found in greatest abundance in brushy bottoms along creek flats. The narrow flats along Rock Creek in the lower part of the Zoölogical Park are thickly marked with their ridges and the little round holes that lead into the burrows. Most of the traps that I set on this flat for moles caught only pine mice, a large number of which were also caught in traps set along the little creek in Woodley Park. A few were caught along Piney Branch and Broad Branch, and one near Fort Marcy, on the west side of the Potomac. Mr. Green caught them on the flats between the canal and Potomac, about a mile above Georgetown, and on a wooded knoll a quarter of a mile below the west end of Long Bridge.

Synaptomys cooperi. Cooper's Lemming-mouse. In 1888 Dr. Fisher examined some pellets of long-eared owls from Munson Hill, Virginia, and among 176 small mammal skulls in these pellets were 3 skulls of *Synaptomys.* Another skull was found in the stomach of a red-tailed hawk killed at Sandy Springs, Maryland, March 24, 1890.* It was, of course, impossible to know the exact localities where the hawks and owls procured these rare specimens. In February, 1896, I caught 4 *Synaptomys* in a sphagnum swamp near Hyattsville, 5 miles northeast of the Capitol, where their nests and runways are common in the damp, cool sphagnum. No doubt more careful trapping would have resulted in a greater number of specimens. As the animals have been so long suspected and so thoroughly trapped for in various places about the District, it is reasonable to infer that they are restricted to these cold swamps.

Zapus hudsonius. Jumping Mice have been taken on the west side of the Potomac close to the city. Morris M. Green caught several at a point a quarter of a mile below the west end of Long Bridge and about

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*A. K. Fisher: Hawks and Owls of the United States. Bulletin 3, Div. of Ornithology and Mammalogy, 1893, pp. 59 and 141.

50 yards from the river. He writes me that they were found in brush heaps and beds of weeds and were caught in his hands in the daytime. Dr. Merriam caught one in 1886 at a point a short distance up the river from the west end of Aqueduct Bridge. Mr. Miller saw one near Forest Glen, Md., on May 10, 1896.

Lepus sylvaticus. The Cotton-tail Rabbit is the principal game mammal of the District and vicinity, and, in spite of the abundance of hunters and dogs, they are still fairly common. I have frequently seen them on both sides of Rock Creek near the Connecticut Avenue bridge and in the Rock Creek Park near Broad Branch. Every fresh snow shows a lot of rabbit tracks among the spruces in the Department of Agriculture grounds, and the rabbits are frequently seen running from bush to bush. They are common in the tall grass and among the brush on the river hills along the west side of the Potomac, where the rough country and rocks offer the best of protection. Part of the immense number of these rabbits exhibited for sale in the markets during fall and winter months are shipped in from beyond the 20-mile circle, but many are taken within a few miles of Washington. A negro hunter is frequently met coming in from the country with an old shotgun and a back-load of rabbits; but when questioned he usually avoids telling where his game was procured. Last February I watched a negro trapper from Westmoreland county, Virginia, selling his stock of furs to a dealer in Center Market, and among other skins 130 rabbits were sold at 1 cent each.

Felis domesticus. I am sorry to have to include the House Cat as an introduced species, but it seems thoroughly naturalized and of too great importance to be omitted. Its tracks are common in dusty wood paths and on every fresh snow in the wildest parts of the surrounding country.

Lynx rufus. Wildcats still inhabit the Blue Ridge Mountains, and it would be strange if they did not sometimes follow down the river cliffs on the west side of the Potomac to near the city. There is much wild country within a few miles of Washington where they could find plenty of small game and be fairly safe from enemies. Dr. Fisher caught one in October, 1895, at Lake Drummond, Virginia, where he reports them as very common.

Vulpes pennsylvanicus. The Red Fox is now fairly common in the country around Washington, though a century ago it was not known here. Dr. Fisher gives me the following interesting note: "Through the kindness of H. H. Miller we learn that the red fox first appeared in Montgomery County, Maryland, between the years 1798 and 1802. He obtained the facts from Mr. George E. Brooke, a gentleman of 80 years of age, who, like his father and grandfather, was an enthusiastic fox-hunter."

D. B. Warden, in writing of the District of Columbia in 1816, says: "The gray and red fox frequent this region, and sometimes carry off pigs, lambs, and poultry." *

Urocyon cinereoargenteus. Gray Fox. This species is still found in the vicinity of Washington, though not in abundance.

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* Chorographical and Statistical Description of the District of Columbia, p. 159, Paris, 1816.

Procyon lotor. The Raccoon is not rare, even in the immediate vicinity of Washington. I have seen their tracks along Rock Creek in the lower end of the Zoölogical Park, on the bank of the Potomac near High Island, and along Beaver Dam Branch on the east side of Anacostia River. Skins are brought into the market by negro trappers from across the Potomac.

Mephitis mephitica. Skunk. In 1894 a skunk was found under a house in the middle of Georgetown. It was treated with carbon bisulphide, and its skin is now in the Department of Agriculture collection in the National Museum. They are fairly common along the Potomac River above Georgetown, where their tracks may be found in the dusty road along the canal almost every morning, and I have found both tracks and holes on the west side of the Potomac, above Chain Bridge. Tracks are less frequently seen in other localities near the city, and occasionally an unmistakable skunky odor blows into town.

Lutra hudsonica. Otters are scarce, but probably less so than is generally supposed. Dr. Coues mentions one brought into the National Museum in the flesh in 1874.* A man living near High Island tells me that an otter has been on the island during the past winter, and that one was caught near Great Falls. I cannot vouch for the truth of these reports, but see no reason to doubt them. The rapids of the Potomac and the rocky shores, with numerous drift-heaps and overhanging banks, offer the favorite environment for otter.

Lutreola vison. Mink are common along the Potomac, along Rock Creek, Anacostia River, Beaver Dam Branch, and probably on every small stream in the District. I have seen their tracks in all of the places mentioned, and the freshly killed animals have been brought to the Department of Agriculture from several points near Washington. One was brought in last February from College Station, Maryland, 8 miles northeast of the city.

Putorius noveboracensis. Weasels, while not plentiful, are by no means rare. Tracks are occasionally seen on the banks of streams. The National Museum contains a number of skins labeled Washington, and in the Department of Agriculture collection are two skins of weasels caught near the city. One of these I caught in April, 1896, a short distance above the west end of Chain Bridge. The spot was close to the old District line, but I could not tell on which side. Mr. C. W. Richmond tells me that a small weasel was caught a few years ago near the Central High School.

Sorex personatus. This tiny Long-tailed Shrew is one of the rarest mammals of the region. It has not yet been taken within the District of Columbia, though no doubt it occurs in very limited numbers in some of the swamps. In the mammal collection of Dr. Merriam there is a much-damaged specimen, picked up in a path near Sandy Springs, Maryland, some years ago. During February of the present year (1896) I succeeded in catching three of these shrews in a sphagnum swamp near Hyattsville,

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* Fur-bearing Animals, p. 311, 1877.

5 miles northeast of the Capitol, but even in this semi-boreal swamp they seem to be scarce and are difficult to secure. Thorough and unsuccessful trapping for them in various localities about Washington proves to my own satisfaction that they do not inhabit the uplands.

Blarina brevicauda. Next to the meadow mouse, the Short-tailed Shrews are probably the most abundant mammals in the District of Columbia. They may be found anywhere in woods and brush and old fields and along creek banks and ditches. Under the cover of fallen leaves and grass and in burrows and covered runways they work their way safely into the very edges of the city. I have taken at least a hundred from traps set for more desirable species along the east side of Rock Creek near the Connecticut Avenue bridge and on the west side near the Massachusetts Avenue bridge, besides others along Piney Branch, Broad Branch, above Georgetown on the west side of the Potomac, and on the east side of Anacostia River near the mouth of Beaver Dam Branch and near Bladensburg. Other mammal collectors have had the same experience of catching more of these shrews than were wanted.

Blarina parva. The Little Short-tailed Shrew is common at Sandy Springs, Maryland, from which point Dr. Merriam has a large series of specimens, but there is not to my knowledge any record of specimens that have been taken nearer Washington. My own traps have not been set in the right kind of localities for this shrew, and probably for the same reason other trappers have not caught it. No doubt it will yet be found common within the limits of the District. Dr. Fisher took 21 skulls from pellets of barn owls found in the Smithsonian tower.

Scalops aquaticus. Moles are common about Washington, and sometimes their ridges are seen on unpaved ground in the city. The only visible sign of their presence is a little ridge pushed up along the surface of the ground and often extended in an interminable network. These ridges, however, are not always a sure sign of the presence of moles, for the pine mouse either makes similar ridges or occupies those abandoned by the moles, but enough moles have been caught in the near vicinity of the city to establish the fact that they are common. Morris M. Green caught them along Rock Creek and the Potomac; E. A. Preble caught one at Arlington; G. S. Miller, Jr., secured one at Forest Glen, Md., and Dr. Mearns tells me that half a dozen specimens have been brought to him at Fort Myer, Va.

Condylura cristata. Star-nosed Moles are either very rare or else their peculiar underground mode of life keeps them well out of the hands of collectors. The only record for the District of which I am aware is that of a family of five young found by Morris M. Green in a nest under an old log on the flats between the canal and river about a mile above Georgetown. As the animal has a general boreal range, it might be expected to occur in the vicinity of cold swamps. I have no doubt that thorough trapping may prove them to be common in certain localities.

Vesperugo georgianus. Morris M. Green, Dr. Fisher, and Dr. Merriam agree that this is the commonest bat in and around Washington.

In June and July of 1888 Mr. Green shot a large number of bats of this species in Rock Creek valley on the present site of the Zoo. In Dr. Merriam's collection are 16 specimens, taken May 14, 1887, under the roof of a barn near the Soldiers' Home, and also a nursing female, shot July 3, 1888.

Vesperugo fuscus. Brown Bat. This is the common large bat seen on summer evenings flying about the streets of Washington. It frequently enters houses through open windows. Specimens have been secured as early as March 8 and as late as December 25.

Vespertilio lucifugus. This is one of the common bats of the city. Mr. Green and Mr. Richmond have captured large numbers of them in the crevices between the timbers under Long Bridge. In Dr. Merriam's collection are 10 adults and 15 young taken June 16, 1889, and a nursing female taken July 3, 1888. Three specimens in the National Museum were collected in May, June, and August.

Vespertilio subulatus. Mr. Gerrit S. Miller, Jr., killed one of these bats at Forest Glen, Maryland, only 8 miles from Washington, May 10, 1896, and found another dead on May 26, 1896. In the National Museum there is one specimen collected at Alexandria, Va., in August, 1875, by P. L. Jouy. These dates may indicate that the bat is a summer resident, but if the species were not rare more specimens would certainly have found their way into collections.

Atalapha borealis. Dr. Fisher considers this next to *Vesperugo georgianus*, the commonest bat in the city. Mr. Green reports it as common in the country and in the city streets, and says he has seen it flying about in November. I have examined Washington specimens collected in May, June, September, and November. In the collection of Dr. Merriam there is a female taken June 22, 1889, with two young clinging to her.

Atalapha cinerea. Hoary Bat. A single skin in the National Museum collected at Laurel, Maryland, brings the species within the 20-mile circle. This specimen was taken October 2, 1892, and was probably a migrant. Other records from Baltimore, Maryland, New Jersey, South Carolina, Massachusetts, and Pennsylvania bring the range of the species on all sides of Washington.

Lasionycteris noctivagans. Dr. Fisher shot one of these bats November 12, 1885, between Arlington and Rosslyn, Va. In the National Museum collection are two skins, one labeled Washington, D. C., January, 1893, the other Smith Island, Va., September 3, 1893. These dates indicate that the species is a migrant or winter visitor.

VOL. X, PP. 103-107 JUNE 15, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

THE EARLIEST RECORD OF ARCTIC PLANTS.

BY THEO. HOLM.

Through the courtesy of Dr. Edw. L. Greene my attention has been called to the fact that our knowledge of the Arctic flora is not of recent date. The invaluable botanical library which Dr. Greene has accumulated, and which is now located in the Catholic University in Washington, D. C., contains a vast number of old books, which are truly a great boon to the working botanist. It was in this library that Dr. Greene showed me a short chapter in Ray's Historia Plantarum,* wherein is enumerated and described some plants collected in Spitzbergen more than two hundred years ago.

The chapter referred to is headed "Plantæ Spitzbergenses a Frederico Martens Hamburgensi in itinerario suo observatæ delineatæ et descriptæ." When I examined the names "*Aloefolia florum capitulis rotundis*," etc., and the accompanying descriptions, which latter might just as well have represented almost any plant outside the Arctic, I felt discouraged. The title of the chapter, however, gave the clue—*i. e.*, the original record by Martens, who was said to have not only described these plants, but even to have figured them.

This is the work which Ray mentions in a letter to Dr. Hans Sloane,† where he expresses his great admiration of the careful observations made by Martens. Martens' own account appeared in his famous little book "Spitzbergische oder Groenlandische Reisebeschreibung gethan im Jahr 1671."* Martens was the surgeon of the ship "Jonas im Wallfisch," which got as far north as the 81st degree of latitude. From here he visited the northwestern part of Spitzbergen, from whence he brought home several specimens of animals and plants.

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* John Ray, vol. III, London, 1704, p. 226, Appendix.

† Correspondence of John Ray, edited by Edwin Lankester, London, 1848, p. 474.

Many of the observations in Martens' book show that he was possessed of unusual energy and skill as a scientific traveler. His voyage was made during a period when Spitzbergen was annually visited by a large number of whalers from various countries in Europe. So great was the traffic that from 1670 to 1710 not less than 2,289 ships visited this island, killing the vast number of nearly ten thousand whales. I have not been able to find any record of the Arctic flora prior to the period named, so that Martens is believed to have been the first writer on the Arctic flora.

His descriptions of Arctic plants are given in the third part of his book (page 41) "Von den Pflanzen so ich in Spitzbergen gefunden." The descriptions are accompanied by four plates, illustrating in all fourteen species. Although the diagnoses are somewhat puzzling, they certainly are much more accurate than those given by the learned English botanist, and his drawings, as a supplement, will enable the reader to identify the phanerogams and one of the two algæ.

The first plant which Martens describes is "Kraut mit Aloeblättern" (Table G, Fig. *a*), which Ray named "*Aloefolia florum capitulis rotundis.*" This plant, judging from the illustration, is undoubtedly *Saxifraga stellaris* L., forma *comosa* Poir. The statement that the flowers form small, flesh-colored heads ("nudo oculo vix discernendi") would seem to indicate that this plant is the Arctic forma *comosa*, the flowers of which are transformed into small bulblets. Besides this, the basal leaves of the drawing agree better with this than with *S. nivalis* L.

"Eingekerbtes Kleinhauswurtz" (Table F, Fig. *a*) is well drawn and represents *Saxifraga nivalis* L. The "Hauswurz" of the Germans is now the popular name for *Sempervivum tectorum*, so that the identification is not so far wrong. Ray has described this plant under the name "*Sedum minus dentatum, capitulis squamosis.*" The flowers are described in this species as having five petals, so that Martens would surely have seen the single flowers of the foregoing species, if there had been any, instead of simply speaking about their forming small heads, a fact which seems to favor the supposition that he meant the bulblets, as I have mentioned above.

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* **Friderich Martens, Hamburg, 1675.**

Four species of " Hanen-Füssen " (" Crowfoot ") are also fully described and accurately figured. One of these, however, is *Saxifraga rivularis* L. (Table H, Fig. C). The others are: *Ranunculus hyperboreus* Rottb. (Table H, Fig. *c*), *R. pygmæus* Wahlbg. (Table G, Fig. *e*), and *R. sulphureus* Soland (Table I, Fig. *d*). The *Saxifraga* he describes as having white petals, and the figure given is a good illustration of this species. Ray has named these "*Ranunculi Spitzbergenses.*"

" Löffel-Kraut " is a species of *Cochlearia*, and this name is still the popular one for the plant. It was undoubtedly *C. fenestrata* R. Br., which is so far the only known species from Spitzbergen. Ray, it appears, accepted Martens' identification, but, although he did not find any difference between this and *C. Britanica*, he nevertheless called it *C. Spitzbergensis.*

The " Kraut als Mauerpfeffer " (Table F, Fig. *c*) is *Saxifraga oppositifolia* L. " Mauerpfeffer " is now the German name for some *Sedum*, to which the plant shows great resemblance. The flowers are described as purple, which agrees well with this species of *Saxifraga*. Ray called it "*Sedum minimum vermiculatum purpureum Spitzbergense.*"

" Natter-wurtz " (Table I, Fig. *a*) agrees well with *Polygonum viviparum* L., according to the description and illustration. This plant is very closely related to *Polygonum bistorta*, which is the proper " Natterwurz " of the Germans. Ray came to the same conclusion as Martens and named it "*Bistorta minor Spitzbergensis.*"

" Kraut als Maüse-Oehrlein " (Table G, Fig. *d*) is exceedingly well illustrated and described and represents *Cerastium alpinum* L., of which the German name is at present "Alpen-Hornkraut." " Mäuseoehrchen " is now used for *Hieracium Pilosella* L., while " Mäusoehrlein," according to Lœselius,* is the name for some species of *Gnaphalium* and *Myosotis*. *Myosotis* is, so far as the name itself is concerned, the only plant to which this name " Mouse-ear " could be applied, as it was by Dioscorides, from the Greek μῦς, a mouse, and οὖς, ὠτός, an ear. The leaves of *Cerastium alpinum* very closely resemble those of a *Myosotis*, so that it can easily be seen how the mistake occurred. "*Auriculæ muris affinis herba Spitzbergensis*" is the name given by Ray to this plant, but his diagnosis, "Supremo cauliculo Flos innascitur albus," is the only feature which is characteristic of this *Cerastium.* Martens has, indeed, pointed out the characteristics in a much clearer way.

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* Johannes Lœselius: Flora Prussica, Regensburg, 1703.

"Kraut als Singrün" (Table G, Fig. *b*) represents *Salix polaris* Wahlbg. If it were not that the illustration is so good, it would hardly have been possible to identify this plant. "Singrün" is now the name for *Vinca.* The stem is described as knotted and woody and the leaves as occurring in pairs. The flowers were not seen, and Martens is therefore not certain that the plant belongs to *Pyrola minima.* It is called "*Vinca pervincæ similis herba Spitzbergensis*" by Ray. The leaves of this willow are very small and coriaceous, brilliant green. They occur in about two alternately on each branch, and to a certain extent resemble those of some species of *Pyrola.*

"Erdbeer-Kraut" (Table H, Fig. *b*) is *Potentilla fragiformis* Willd. The description is very good, and the statement that the leaves only had three leaflets shows that we have this species before us and not *P. maculata* Pourr., the leaves of which are quinate. The same statement is also given by Ray, "foliis tripartitis divisis . . . ," who has called it "*Fragariæ affinis Spitzbergensis.*"

Two Algæ are enumerated under the name "Klippen-Kraütern," of which the figure *b* in Plate F represents *Fucus vesiculosus.* The vesicles are described very accurately, and Martens states that he did not observe whether these contained any seeds. His sailors informed him, however, that the small sea snails (Pteropoda), upon which the whales feed, originate from the seeds of this Alga. Martens does not seem to have shared this opinion, however, and says that he is inclined to believe that these snails have, like others, originated from eggs!

The large Alga (Fig. *c* in Plate I) is undoubtedly a species of *Laminaria.*

Several other plants were observed, but were not collected. Only two of these have been described, but these have not been figured. One of these, "*der weisse Mahn,*" is evidently *Dryas octopetala* L. "Mahn" is undoubtedly a misprint for "Mohn," the common poppy (*Papaver dubium* or *Rhœas*). Since the only poppy that grows on Spitzbergen, *P. nudicaule* L., has yellow flowers, it is not likely that Martens meant this plant, but rather the common white *Dryas*, which is not so very unlike a poppy. The other plant is "der rothe Sauerampffer," which probably was *Oxyria digyna* Campd., now called "Saüerling" by the Germans.

If the list of plants collected by Martens be compared with the most recent publication on the flora of Spitzbergen,* it will be seen that all the species named in the list have actually been rediscovered by later expeditions. As to the locality where they were collected, it appears that they were found in the neighborhood of Smeerenberg, on the northwestern shore of Spitzbergen, designated by Martens as "Harlinger Kocherey."

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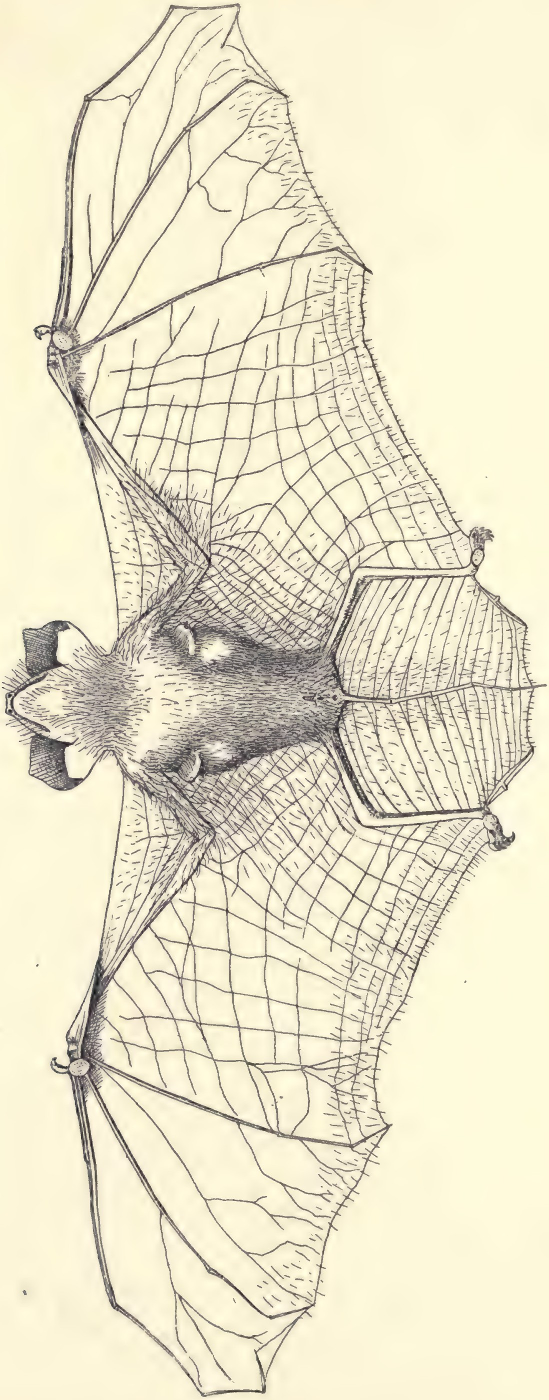
* Nathorst, A. G., Nya Bidrag till Kännedomen om Spetsbergens Kärlväxter, Stockholm, 1883, Kgl. Sv. Vet. Akad. Hdlgr., vol. 20, No. 6, 88 pp.



Thyroptera discifera (Lichtenstein and Peters) ♀ ad. (Slightly enlarged)

VOL. X, PP. 109-112, PL. VII JULY 22, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

THE CENTRAL AMERICAN *THYROPTERA*.

BY GERRIT S. MILLER, JR.

Three specimens of *Thyroptera*, collected by G. E. Mitchell on the Escondido River at a point about fifty miles from Bluefields, Nicaragua, and now in the collection of the United States Department of Agriculture, are clearly referable to the species described by Lichtenstein and Peters in 1855 as *Hyonycteris discifera*.[*] This bat was recognized as a distinct species by Tomes in a paper published in the Proceedings of the Zoölogical Society of London for 1856 (p. 179), but Dobson, in 1878,[†] placed the name *Hyonycteris discifera*, together with *Hyonycteris albiventer* Tomes[‡] and *Thyroptera bicolor* Cantraine[§] among the synonyms of the Brazilian *Thyroptera tricolor* Spix. While no specimens of the three nominal and probably valid South American species[||] are available for comparison with the Nicaraguan bat, there can be no doubt that the latter differs widely from any of these. It may be redescribed as follows:

Thyroptera discifera (Lichtenstein and Peters).

Hyonycteris discifera Lichtenstein and Peters, Monatsber. K. Preuss. Akad. Wiss., Berlin (1854), p. 335, 1855.
Tomes, Proc. Zoöl. Soc. London, 1856, p. 179.

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[*] Monatsber. K. Preuss. Akademie Wiss., Berlin (1854), p. 335, 1855.

[†] Catalogue of the Chiroptera in the British Museum., p. 245, 1878.

[‡] Proc. Zoöl. Soc. London, 1856, p. 179.

[§] Bull. Acad. Roy. Sci. Bruxelles, VII, p. 489, 1845.

[||] The type localities of these are: *Thyroptera tricolor*, Brazil; *T. bicolor*, Surinam; *T. albiventer*, Napo River, near Quito, Ecuador.

Thyroptera tricolor Dobson, Catalogue of the Chiroptera in the British Museum, p. 345, 1878 (in synonymy only; the description refers strictly to South American specimens).

Type locality.—Puerto Caballos, Honduras.

Geographic distribution.—Central America from Puerto Caballos, Honduras, south to Bluefields, Nicaragua.

General characters.—Size small; length about 45 mm.; tail, 26; forearm, 31. Calcar slender, distinct, slightly longer than free border of interfemoral membrane, terminating in an ill-defined lobule; the posterior edge with a well-formed keel supported by one strong cartilaginous process. Terminal 2 mm. of tail free. Free border of uropatagium with a few scattered hairs. Ears short, funnel-shaped, acutely pointed, when laid forward reaching barely to tip of nose. Wings from middle of claws. Third and fourth toes closely approximated and firmly bound together.

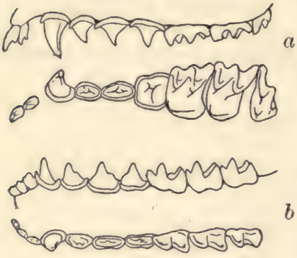

FIG. 1.—Teeth of *Thyroptera discifera*; *a*, upper; *b*, lower (× 5).

Teeth.—Dental formula as usual in the genus: $i\,\frac{2\text{–}2}{6}$, $c\,\frac{1\text{–}1}{1\text{–}1}$, $pm\,\frac{3\text{–}3}{3\text{–}3}$, $m\,\frac{3\text{–}3}{3\text{–}3} = 38$. The teeth (Fig. 1) are small and weak for the size of the skull. Upper incisors bifid,* in pairs, the outer tooth half as large as the inner and separated from the canine by a space about as wide as the crown of the larger incisor. Premolars all in the tooth row, not separated by spaces from each other or from the adjoining molar and canine, first slightly smaller than second, third slightly more than half as large as first molar. Crown of first molar broadest, crown of second longest. Lower incisors trifid, the crown of the outer as broad as that of the first and half of the second. First lower premolar smaller than second, but larger than canine. Middle lower molar largest.

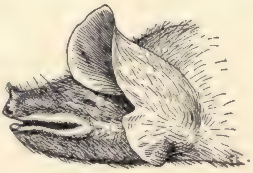

FIG. 2.—Head of *Thyroptera discifera* (× 3).

Ears.—The ears are short, acutely pointed, funnel-shaped, and directed forward. The tips do not reach tip of nose when the ears are laid forward. The anterior border is strongly convex from base to small concavity just below very narrowly rounded off tip. Posterior border concave immediately below tip, then convex to basal notch. The basal notch is strongly developed and isolates a very large lobe which joins side of head below line of lips (Fig. 2).

Tragus short and broad, the tip thickened and bent abruptly forward; a large thickened basal lobe directed forward and outward, and a minute process directed backward just above posterior base.

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* Dobson states that in *Thyroptera tricolor* the outer incisor is unicuspidate.

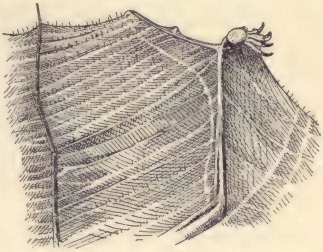

FIG. 3.—Foot and uropatagium of *Thyroptera discifera* (× 2).

Membranes.—The membranes are thin and semitransparent, broad and ample. Wings attached at middle of claws, sparsely hairy from sides of body to line connecting elbow and knee. The free edge has also a narrow hairy border. Antebrachial membrane hairy near base and along humerus and fleshy part of forearm, which in turn are covered with hair. Uropatagium sparsely haired throughout on dorsal surface, otherwise naked, except at extreme base and along veins on ventral surface.

Feet.—The feet are small, weak, and so turned outward as to be nearly in line with calcar (Fig. 3). Toes with two phalanges, of which the second is very small and serves merely to support the long claw. All the fingers are bound together by membrane to about the middle of the claws, while the third and fourth digits are firmly united, so that the two claws, although really separate, form what is apparently one strong nail, shorter and more abruptly curved than the others (Fig. 4). Calcar strong, distinct, longer than free border of uropatagium, terminating in a small lobule and bearing a well-formed keel, supported by one strong cartilaginous process. Sucking disk circular, the margin next the phalanges distinct, that toward the keel not sharply marked off from sole.

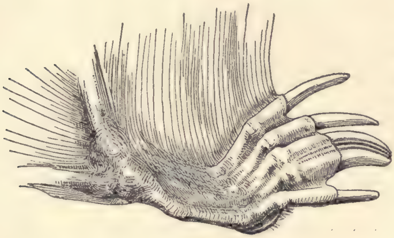

FIG. 4.—Right foot of *Thyroptera discifera* greatly enlarged to show syndactylism of third and fourth digits.

Fur and color.—In distribution, the fur is peculiar in its extension on the wings and dorsal surface of the interfemoral membrane. Color dull yellowish brown throughout, scarcely paler ventrally, the hairs without darker bases. Ears and membranes dusky brownish.

Measurements.—No. 51538, ♀ ad., Escondido River, Nicaragua; total length, 66 mm.; head and body, 37.6; tail, 26; free tip of tail, 2; femur, 13; tibia, 13.4; foot, 4; forearm, 31; third finger—metacarp., 29.8; first ph., 14; second ph., 7.8; fourth finger—metacarp., 28.6; first ph., 10; second ph., 4.6; fifth finger—metacarp., 26; first ph., 8; second ph., 5.6; ear, 11.6; width of ear, 12; tragus, 4; diameter of disk on thumb, 3; diameter of disk on foot, 2.

No. 51539, ♀ ad., same locality and date; total length, 65; head and body, 38; tail, 26; free tip of tail, 1.8; femur, 14; tibia, 14.8; foot, 4.8; forearm, 31.6; third finger—metacarp., 29; first ph., 13.4; second ph., 8.4; fourth finger—metacarp., 29; first ph., 9; second ph., 5.4; fifth finger—metacarp., 25.6; first ph., 7.4; second ph., 6; ear, 12; width of ear, 12; tragus, 3.6; diameter of disk on thumb, 3.4; diameter of disk on foot, 2.

General remarks.—Of the three South American species of *Thyroptera*, two (*T. bicolor* and *T. albiventer*) are described as sharply bicolor, brownish above and white beneath, while the third (*T. tricolor*) is said by Dobson to be reddish brown on the back and pale yellowish white on the abdomen, and also to have dental characters not found in the Nicaraguan animal. In *Thyroptera tricolor* and *T. bicolor* the free part of the tail equals one-fourth or one-third of its whole length. In *T. discifera*, on the other hand, only the terminal joint and part of the penultimate joint project beyond the edge of the interfemoral membrane. *T. albiventer* is said to have the terminal joint only of the tail free, but the type specimen of this species was so mutilated that no dependence can be placed on this character. In size the four forms apparently agree very closely—at least it is impossible to find any important differences in the measurements given in the original descriptions.

The characters of *Thyroptera discifera* and of the South American species as described may be thus contrasted:

Both upper incisors bifid	*discifera*
Only the inner upper incisor bifid	*tricolor*
Sharply bicolor, or color of back distinctly different from that of belly	*albiventer, bicolor, tricolor*
Essentially unicolor	*discifera*
One-fourth to one-third of tail free from inter-femoral femoral membrane	*tricolor, bicolor*
Only tip of tail free	*albiventer* (?) *discifera*

The syndactylism of the third and fourth digits of the foot may prove to be peculiar to *Thyroptera discifera*. It is mentioned by Lichtenstein and Peters in the original description of the species, but none of the authors who have described South American specimens make any allusion to such a condition, although in most cases they have mentioned the form of the feet and claws with considerable detail.

Another character of *Thyroptera discifera* not mentioned in descriptions of the South American species, but probably common to all, is the large and conspicuous clitoris (see pl. VII). In the adult female this measures 1.6 mm. in length and is about half as long as the penis of a nearly full grown male. The vulva opens longitudinally with the anterior commissure encroaching on the basal third of the clitoris.

Vol. X, pp. 113-114 July 22, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

NOTE ON THE MILK DENTITION OF *DESMODUS.*

BY GERRIT S. MILLER, Jr.

Some immature specimens of *Desmodus rufus*, taken by Mr. E. W. Nelson, at Etzatlan, Jalisco, Mexico, in June, 1892, and now in the collection of the United States Department of Agriculture, retain the greater part of the milk dentition, though it is probable that none are young enough to present a complete set of deciduous molars. The extraordinary specialization of the teeth of this bat correlated with the animal's strictly sanguivorous habits make any facts relating to the early development of the teeth of special interest.

In the adult (Fig. 1, *e*, and 2, *c*) the dental formula is $i\ \frac{1-1}{2-2}$, $c\ \frac{1-1}{1-1}$, $pm\ \frac{2-2}{3-3}$, $= 20$. The milk dentition, so far as it can be determined, is as follows: $di\ \frac{2-2}{2-2}$, $dc\ \frac{1-1}{1-1}$, $dm\ \frac{1-1}{2-2} = 18$.

The largest of the deciduous teeth are the upper incisors (Fig. 1, *di* 1 and *di* 2). These cut the gums some time before the

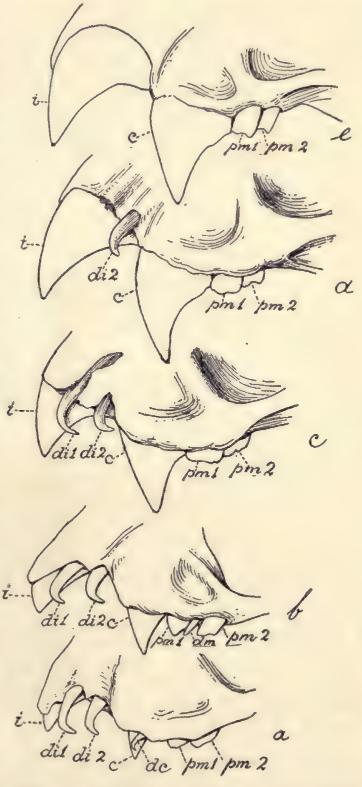

Fig. 1.—Maxillary teeth of *Desmodus rufus*, showing milk dentition and gradual change in form of permanent teeth from very young (*a*) to adult (*e*) (× 5).

permanent incisors (Fig. 1, *i*), and even after the appearance of the tips of the latter remain for a considerable period tne most conspicuous teeth in either jaw. Their strongly recurved tips are probably of great service to the young when clinging to the nipple of the female during flight. At first the anterior deciduous incisor lies on the outer side of the permanent incisor, while the posterior deciduous incisor occupies the space between the permanent incisor and canine (Fig. 1, *a*). As the permanent incisor increases in size, it gradually extends backward until both milk incisors appear closely appressed to its outer face. In this condition (Fig. 1, *c*) the teeth remain until the animal acquires a large size, while the second milk incisor often persists in nearly full-grown individuals (Fig. 1, *d*). The deciduous canine (Fig. 1, *a*, *dc*) lies imbedded in the gum on the outer side of the prominence caused by the growing permanent canine. It is shed at an early age, and never becomes in any way functional. A deciduous molar (Fig. 1, *b*, *dm*) was found occupying a position near the posterior outer border of the first permanent upper premolar in two specimens. This tooth lacks the recurved tip and must be wholly functionless.

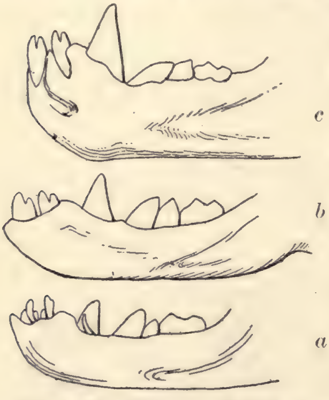

FIG. 2.—Mandibular teeth of *Desmodus rufus*, showing part of milk dentition (*a*) and gradual change in form to adult (*c*) (× 5).

In the lower jaw (Fig. 2) the deciduous teeth are smaller and less conspicuous than those in the upper jaw. They are also shed at a much earlier period. On opening the mouth of one specimen (No. 52130) I found two deciduous molars lying loose on the gum over the permanent premolars. The exact position of these milk teeth could not be determined, and I failed to detect any trace of them in other individuals. The deciduous mandibular canine closely resembles its counterpart in the upper jaw, both in size, position, and history. Its tip is, however, less strongly hooked (Fig. 2, *dc*). The deciduous lower incisors (Fig. 2, *di*) are very small and loosely attached to the gum through which they scarcely pierce before they are shed. In form they are totally different from the corresponding upper teeth. Their tips are somewhat widened and faintly notched, thus suggesting the form presented by the permanent lower incisors of many bats.

VOL. X, PP. 115-118 NOVEMBER 3, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

A NEW FIR FROM ARIZONA, *ABIES ARIZONICA.*

BY C. HART MERRIAM.

In the summer of 1889, when making a biological survey of the San Francisco Mountain region in Arizona, I discovered a new fir with whitish corky bark. The scales of the cones were shed before the end of September, and no perfect cones were brought back. In my report on the 'Forest Trees of the San Francisco Mountain Region' I described this 'white cork-bark fir' under the head of *Abies subalpina* Engelm. [= *Abies lasiocarpa* Hooker], with the following explanation: "I believe this tree to be distinct from true *A. subalpina*, but in the absence of material for direct comparison I am unwilling to separate it." My original account of the species is as follows: "This beautiful fir, unique in the color and character of its bark, is one of the most conspicuous trees on San Francisco Mountain between the altitudes of 2,725 and 2,900 meters (8,950 to 9,500 feet). On the north side of a large butte, just south of Walker Lake crater, it descends to 2,600 meters (8,500 feet). The bark is a fine elastic cork of uniform texture, and free from hard particles. It averages about 6 millimeters in thickness and is very durable, frequently remaining intact while the wood rots away. Large pieces of it, still retaining their elasticity, may be stripped from dead trees and from logs upon the ground. It is sculptured by irregularly interrupted longitudinal depressions or grooves, and is ornamented by fine, parallel, wavy lines. Its color varies from creamy white to gray, and the surface has a velvety texture. The leaves are short, and the scales of the large cones are deciduous while still on the tree. In fact, it was almost impossible to secure a perfect cone as early as the latter part of September. * * *

"On Kendrick Peak it grows from the south rim of the crater (altitude about 2,800 meters, or 9,200 feet) to the summit (a little above 3,050 meters, or 10,000 feet)."*

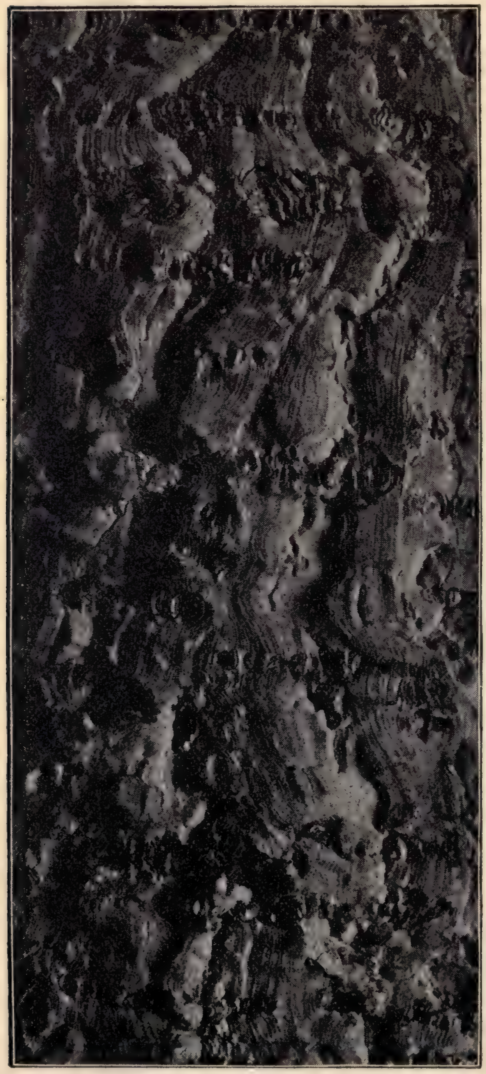

FIG. 24.—Bark of *Abies arizonica* (natural size).

Early in July of the present year (1896) I again visited San Francisco Mountain and, in company with Dr. B. E. Fernow, had the satisfaction of obtaining upper and lower branches, fresh cones, and bark of the new tree, which may be defined as follows:

Abies arizonica sp. nov.

Type from west slope of San Francisco Mountain, Arizona. Altitude, about 3,000 meters (approximately 10,000 feet). Collected July 2, 1896. No. 270,604. U. S. National Herbarium.

Range.—Hudsonian Zone of San Francisco and Kendrick Mountains, Arizona; not reaching timber line.

Characters.—Size of tree, medium or rather small, averaging about 15 meters in height and rarely 300 millimeters in diameter at base; bark a highly elastic fine-grained cork, whitish or grayish in color, usually creamy white, with irregularly sinuous grayish ridges (Fig. 24); leaves of cone-bearing branches thick, subtriangular in transverse section, and sharp-pointed at apex (about 20 millimeters in length); leaves of lower branches much longer, flatter, blunt, and notched at apex (about 25–30 millimeters in length); cones dark purple, slender, medium, or rather small, those of type specimen (not full grown) measuring about 50 x 20 millimeters; scales much broader than long, strongly convex laterally (Fig. 25, *c*), purple on both sides; bract (without awn) reaching to or past middle of scale; body of bract much broader than long.

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* North American Fauna, No. 3, pp. 120–121, September, 1890.

Remarks.—The only tree with which the white cork-bark fir needs comparison is the subalpine fir (*Abies lasiocarpa* Hooker = *A. subalpina* Engelm.), from which it differs in leaves, bark, and cones. In *Abies lasiocarpa* the leaves of the lower branches average much shorter than in *A. arizonica;* the bark is hard instead of elastic-corky, and is variable in color, usually dark grayish brown blotched with whitish; the cones are larger, and the scales and bracts differ widely in shape and proportions. In *A. lasiocarpa* (Fig. 25, *a* and *b*) the scales are longer than broad, the body of the bract is less than one-third the length of the body of the scale, and the seed wings are about twice as long as broad; in *A. arizonica* (Fig. 25, *c*) the scales are much broader than long, the body of the bract is more than half the length of the scale, and the seed wings are about as broad as long.

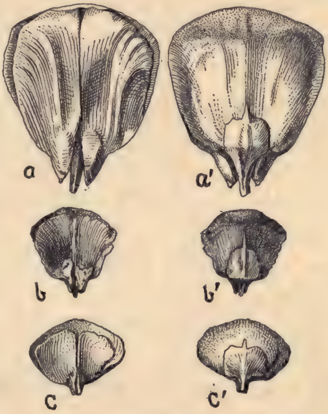

FIG. 25.—Scales of cones (natural size).
a. Abies lasiocarpa, mature.
b. Abies lasiocarpa, young.
c. Abies arizonica, young.
a, *b*, *c*. Upper side, showing seed wings.
a′, *b′*, *c′*. Under side, showing bracts.

The form of the scale and relative size of the bract probably change somewhat with age, but in the accompanying figures the immature scale of *Abies arizonica* (Fig. 25, *c*) is contrasted with a still younger scale of *A. lasiocarpa* (*b*), as well as with the mature scale of the latter (*a*). The young cone of *A. lasiocarpa*, from which the scale figured (*b*) is taken, is decidedly smaller than the cone of *A. arizonica*, from which figure *c* is taken, while the adult cone of *A. lasiocarpa* is more than twice as large. Both of the specimens figured of *A. lasiocarpa* came from Mount Hood, at the north end of the Cascade Range in Oregon, which is probably near the type locality of the species. I am indebted to Mr. F. V. Coville for the opportunity of figuring the young cone of *lasiocarpa*. *Abies arizonica* is a much smaller tree than *A. lasiocarpa*.

Both are highly boreal species, belonging to the Hudsonian Zone, though *A. arizonica* fails to reach the upper or timber-line belt of this zone. *Abies lasiocarpa* ranges from southern Alaska and British Columbia southward, over the Rocky Mountains into Utah and Colorado, and over the Cascade Range to southern Oregon. *Abies arizonica*, on the other hand, is restricted, so far as known, to San Francisco Mountain and neighboring peaks on the summit of the plateau in northern Arizona.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

THE COTTON MOUSE, *PEROMYSCUS GOSSYPINUS.*

BY OUTRAM BANGS.

The present revision of the subspecies of *Peromyscus gossypinus* is based on the study of several hundred specimens in the collection of E. A. and O. Bangs and the type and five topotypes of *Peromyscus gossypinus mississippiensis* kindly lent me by Mr. Samuel N. Rhoads.

LeConte, in 1853, bestowed the name *Hesperomys gossypinus* upon the large dark-colored, white-footed mouse of Georgia. Two years later the same author named what he supposed to be another species from the same general region, calling it *Hesperomys cognatus.* This last name has troubled subsequent mammalogists not a little, until Mr. Rhoads, in his 'Mammals of Tennessee,'* in 1896, relegated it to its proper place, and it became a synonym of *P. gossypinus*, based on the young in the pelage assumed after the plumbeous first coat has disappeared. There is, however, a name earlier than LeConte's *H. gossypinus* that must be considered. It is *Hesperomys polionotus* of Wagner, described in 1843.† This animal is said to have come from Georgia. The measurements and description of the colors of Wagner's specimen show it to have been a very young individual, and now impossible to identify. Wagner gives no definite locality in the State of Georgia, and as *P. aureolus* is found generally distributed throughout that State and as *P. leucopus* undoubtedly occurs in the mountains, it would be unwise to assume that the specimen in question was certainly the young of *P. gossypinus*, and thus allow Wagner's name to stand for that species.

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* Proc. Acad. Nat. Sci., Phila., 1896, p. 189.

† Archiv für Naturgeschichte von Wiegmann, 1843, 2ter. Bd., pp. 51-52. "Aus eben diesem Staate [Georgia] herrührend liess mir Prof. Schinz zwei Mäuse zur Ansicht zukommen, unter denen die eine mit M. Lecontii übereinstimmt. Der andern, die mir unbeschrieben scheint, habe ich den Namen *Mus polionotus* beigelegt: M. supra flavido-plumbeus subtus pedibusque albidus; auriculis mediocribus, dent. prim. integris, cauda pilosa abbreviata. Körper 2″ 4‴, Schwanz 1″ 2‴, Ohren 4‴, Hinterfuss 7‴. Wie schon erwähnt, werden beide nicht zu Mus gehoren, doch ist mir ihr Gebiss unbekannt."

Two names have been given lately to subspecies of *gossypinus* by Mr. Samuel N. Rhoads. One of these, the so-called *Sitomys megacephalus*, from Woodville, Alabama,* becomes a synonym of *P. gossypinus.* I have not seen the type, which is in alcohol, but there are no characters attributed to it that can in any way separate it from true *gossypinus* of Georgia, an animal Mr. Rhoads was wholly unfamiliar with, he making his comparisons with the Florida form, which is subspecifically distinct. The cranial characters claimed for *megacephalus* are individual and in nowise diagnostic. The other is the *Peromyscus gossypinus mississippiensis* of the bottom lands of the Mississippi in Tennessee, and is a well-marked race. I now describe two more races, one from the peninsula of Florida, the other from the bayou region of Louisiana, thus dividing *P. gossypinus* into four subspecies.

Peromyscus gossypinus has been given by authors in recent years as a subspecies of *P. leucopus*, not because any intermediates were forthcoming, but on general principles, until Rhoads, in his 'Mammals of Tennessee,' in 1896, gave it full specific rank. Mr. Rhoads, in the summer of 1895, found *gossypinus* and *leucopus* in the Mississippi bottoms in Tennessee, where, he says, it was possible to catch both species in the same trap, and yet the two kept perfectly distinct. This undoubtedly will prove to be the case wherever the ranges of *P. leucopus* and *P. gossypinus* overlap.

Most of the closely related forms of white-footed mice look very different from each other when one is trapping and handling them in the flesh. This 'aspect difference,' as Professor Shaler aptly calls it, is subtle and hard to define, and may disappear almost entirely when the animals are made into the conventional museum skins or preserved in spirits, thus leaving the characters on which species and subspecies are based very slight in comparison with what they were in life. This is strikingly true of *P. gossypinus*, and I well remember, when I first trapped this beautiful mouse, being astonished to see a creature so wholly different from *P. leucopus*, of which I had previously supposed it merely a subspecies. Since the cranial characters presented by the members of the genus *Peromyscus* are so slight that it is often difficult to tell apart the skulls of very different species, they are naturally of little help in distinguishing closely related forms.

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* Proc. Acad. Nat. Sci., Phila., 1894, p. 254.

Peromyscus gossypinus has a wide range in the lower Austral Zone, extending north along the Atlantic coast to North Carolina, up the Mississippi Valley to Tennessee, and west along the Gulf coast to Louisiana; but it is not found on the higher land between the most northern, eastern, and western points of its range.* *Peromyscus gossypinus* inhabits a variety of situations, but my experience with the typical form in Georgia has been that it is rare. About St. Marys, Georgia, they lived in the hammocks and margins and around the edges of some of the cleared fields, but were not numerous anywhere. I could not find them in the pine woods at all, but their absence there may be due to the annual firing of these woods to make pasture. The Florida form is very abundant in many parts of peninsular Florida. At Oak Lodge, on the east peninsula opposite Micco, I trapped them by the hundred. Their favorite abodes there were the edges of the salt savannah, the piles of brush and rubbish around the cleared fields, and along the edge of the beach in the saw palmetto thickets. In these dense thickets and among the plants and grasses of the upper beach *Peromyscus gossypinus palmarius* and the exquisite little *Peromyscus niveiventris* occurred together in great numbers, feeding largly on the seeds of the sea oats, *Uniola paniculata*.

Peromyscus gossypinus meets or overlaps the ranges of at least four and probably five other white-footed mice. All along its northern limits it must come in contact with *Peromyscus leucopus*, and judging from Mr. Rhoads' experience in Tennessee the two species overlap, but keep distinct. *P. gossypinus* can always be told from *P. leucopus* by its much larger size, stouter build, bigger hind foot, shorter tail, browner and less fulvous coloration of the upper parts, and the gray (not white) under parts. Major LeConte states in his description of *P. gossypinus* that it has longer front legs than *leucopus*, and consequently a different gait, progressing in an even run, while *leucopus* goes by little leaps. I regret to say that while I had the opportunity I never studied the movements of *P. gossypinus* in life. Major LeConte undoubtedly did, and I see no reason to doubt his statement. The skull of *P. gossypinus* averages larger than that of *P. leucopus* when individuals of the same age are compared, but apart from this difference in size the two are indistinguishable.

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*Reelfoot Lake, Tennessee, and Bertie County, North Carolina.

Peromyscus aureolus overlaps the greater part of the range of *P. gossypinus*, but reaches farther north and probably not so far south, the southernmost examples, so far as I know, coming from Enterprise, Florida. It can always be told from *gossypinus* by the bright ochraceous of the upper parts, the under parts being also extensively washed with this color, and its smaller size about that of *P. leucopus.*

In Florida two white-footed mice, very different from each other and equally different from *gossypinus*, occur in many places associated with *gossypinus.* The commoner of these is the most beautiful of all white-footed mice, the little, ghost-like *Peromyscus niveiventris.* This species is about half the size of *gossypinus*, with pale gray and fawn-colored upper parts and snowy white under parts. The other is *Peromyscus floridanus*, an animal very unlike *P. gossypinus* and belonging to a different group of the genus. It is a large mouse, with big, nearly naked ears, short tail, and very large hind foot. The sides are a bright ochraceous buff and the under parts white. The fur is very soft and silky.

In the west *Peromyscus gossypinus* may meet the range of *P. mearnsi* of the lower Rio Grande and coast of Texas. *P. mearnsi* is about the size and proportions of *P. leucopus*, and is dark gray (purplish gray in fresh pelage) above, without a marked darker dorsal band, and white below.

Peromyscus gossypinus (LeConte).

1831. *Hyp[udæus] gossipinus* LeConte, M'Murtrie's Cuvier's Animal Kingdom, I, 1831, app., p. 434 (nomen nudum).

1853. *Hesperomys gossypinus* LeConte, Proc. Acad. Nat. Sci. Phila., 1853, p. 411.

1855. *Hesperomys cognatus* LeConte, Proc. Acad. Nat. Sci. Phila., 1855, p. 442.

1874. *Hesperomys (Vesperimus) leucopus gossypinus* Coues, Proc. Acad. Nat. Sci. Phila., 1874, p. 179.

1877. *Hesperomys leucopus gossypinus* Coues, Monog. N. American Muridæ, p. 76.

1894. *Sitomys megacephalus* Rhoads, Proc. Acad. Nat. Sci. Phila., 1894, p. 254.

1896. *Peromyscus gossypinus* Rhoads, Proc. Acad. Nat. Sci. Phila., 1896, p. 189.

Type locality.—The LeConte plantation a few miles above Riceboro, Liberty County, Georgia.

Geographic distribution.—From northern Florida north along the coast at least to Bertie County, N. C.; west through the non-mountainous parts of Georgia to Alabama and perhaps Mississippi.

Subspecific characters.—A large heavily built mouse; hind foot large; tail shorter than head and body, bicolored; ears dusky, nearly naked, of moderate size; general color of upper parts dark brown, with broad darker dorsal band; under parts gray; feet and hands grayish white.

Color.—Adult: Upper parts dark brown, varying from Prouts brown to sepia, darkening along middle of back into a broad dorsal band, which ranges from clove brown to black; a black orbital ring. Under parts smoke gray, the hairs plumbeous at base; feet grayish white; ears dusky; tail bicolored, dusky above, grayish white below. *Nursing young:* Blackish slate above, slate gray below; tail and feet as in adult. *Young in second pelage:* General color of upper parts duller, more hair brown, often with a sooty cast; otherwise like adult, dorsal stripe well marked.*

Size.—Average measurements of twelve adult specimens from St. Marys, Ga.: total length, 177.66; tail vertebræ, 70.25; hind foot, 22.35. Maximum size (of largest old adult in above average): total length, 197; tail vertebræ, 82.5; hind foot, 22.

Specimens examined, 37, from the following localities:

Georgia: St. Marys, 35.

North Carolina: Bertie County, 2.

Peromyscus gossypinus mississippiensis Rhoads.

1896. *Peromyscus gossypinus mississippiensis* Rhoads, Proc. Acad. Nat. Sci. Phila., 1896, p. 189.

Type locality.—Samburg, Reelfoot Lake, Tennessee.

Geographic distribution.—The Mississippi bottoms in Tennessee; limits of range unknown.

Subspecific characters.—Size about that of typical *gossypinus;* tail a little longer; hind foot larger; colors paler and more yellowish; dorsal band less well defined, without black orbital ring.

Color.—Adult: Upper parts varying from cinnamon brown to russet, darkening on middle of back into an ill-defined dorsal band about mummy brown; no dark orbital ring; under parts grayish white, the hairs plumbeous at base; ears dusky; tail bicolored, dusky above, white below; feet grayish white.

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* The young in this pelage are much smaller than the adults, but as they frequently breed they have the appearance of full-grown animals, and gave rise to LeConte's species *Hesperomys cognatus.*

Size.—Average measurements of six adult specimens from type locality: total length, 183; tail vertebræ, 79.5; hind foot, 24.45. Maximum size (of largest old adult in above average): total length, 196; tail vertebræ, 84; hind foot, 25.

Specimens examined, 6, all from the type locality.

Peromyscus gossypinus palmarius subsp. nov.

Type from Oak Lodge, on east peninsula opposite Micco, Brevard County, Florida. No. 3224, ♀ old adult, collection of E. A. and O. Bangs. Collected by O. Bangs February 23, 1895. Total length, 183; tail vertebræ, 74; hind foot, 21.

Geographic distribution.—Peninsular Florida, north at least to Brevard County on the east and Citrus County on the west.

Subspecific characters.—About the size of typical *P. gossypinus;* hind foot shorter; colors much paler and more yellowish; no decided darker dorsal band; a black orbital ring.

Color.—Adult: Upper parts varying, according to freshness of pelage, from bright russet to wood brown, usually a few darker hairs scattered along middle of back, but not enough to form a dorsal band; a black orbital ring; under parts grayish white, the hairs plumbeous at base; ears dusky; tail bicolored, dusky above, white below; feet grayish white.

Size.—Average measurements of twenty adult specimens from type locality: total length, 181; tail vertebræ, 71.88; hind foot, 21.55. Maximum size (of largest old adult in above average): total length, 206; tail vertebræ, 83; hind foot, 22.

Remarks.—Peromyscus gossypinus palmarius often shows a pectoral spot of yellowish brown, sometimes of large size.

It is often difficult to tell the young in the second pelage of *palmarius* from the young of typical *gossypinus*, but as a rule they are lighter in color, more grayish, less sooty, and have the dorsal stripe much less well defined.

Specimens examined, 166, from the following localities in Florida: Oak Lodge, east peninsula opposite Micco, Brevard County, 111; Micco, 3; Flamingo, 19; Miami, 2; Jupiter Inlet, 3; Crystal River, 4; Citronelle, 3; Blitches Ferry, Citrus County, 21.

Peromyscus gossypinus nigriculus subsp. nov.

Type from Burbridge, Plaquemines Parish, Louisiana. No. 2731, ♀ adult, collection of E. A. and O. Bangs. Collected by F. L. Small January 30, 1895. Total length, 174; tail vertebræ, 79; hind foot, 24.

Geographic distribution.—Bayou region of the coast of Louisiana.

Subspecific characters.—Size smallest of the *gossypinus* series; hind foot about as in typical *gossypinus;* tail proportionally longer; colors very dark; a broad dorsal band nearly black; ears and upper surface of tail black; a black orbital ring.

Color.—Adult: upper parts varying from vandyke brown to sepia, often with a sooty cast; darkening along middle of back into a broad dorsal band of nearly black; a black orbital ring; under parts grayish white; the hairs plumbeous at base; ears black; tail bicolored, black above, grayish white below; feet and hands grayish white.

Size.—Average measurements of three adult specimens from the type locality: total length, 168.33; tail vertebræ, 76.66; hind foot, 23.66. Average measurements of twenty adult specimens from Gibson, Terre Bonne Parish, Louisiana: total length, 169.85; tail vertebræ, 77.85; hind foot, 22. Maximum size (of largest old adult in above average): total length, 184; tail vertebræ, 86; hind foot, 22.

Remarks.—The young of *Peromyscus gossypinus nigriculus* are very dark colored, both in the nursing and the second pelage, and can usually be separated, both by their dark color and their smaller size, from the young of corresponding age of *gossypinus* or of *palmarius.*

This form appears to be confined to the heavy swamps of the bayou region, and probably does not occur farther from the coast than the limits of these swamps. Although Mr. Small trapped persistently in several localities in the prairie and pine regions of central Louisiana, he failed to get a single specimen of any *Peromyscus* in such places and concluded that none occur north of the bayous.

Specimens examined, 89, from the following localities in Louisiana: Burbridge, Plaquemines Parish, 5; Gibson, Terre Bonne Parish, 56; Powhatan Plantation (near Gibson), 28.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

JUNCUS CONFUSUS, A NEW RUSH FROM THE ROCKY MOUNTAIN REGION.

BY FREDERICK V. COVILLE.

In a collection of Juncaceae from Idaho, recently received for identification from Mr. A. A. Heller, were two specimens of an undescribed Juncus, which had long been confounded, even by Engelmann himself, with *Juncus tenuis congestus* Engelm. A description of the species, which was already well represented in the National Herbarium by specimens from other collectors, is given herewith.

Juncus confusus Coville, sp. nov.

Plant perennial, densely tufted, 15 to 60 cm. high, erect; stem 0.5 to 1.5 mm. thick at base, narrower above, striate, nearly terete; leaves all basal, the sheaths with well developed auricles, the blades erect, one-third to one-half or more the height of the stem, flat, usually involute in drying, narrow, 0.5 to 1 mm. in breadth; inflorescence congested into a turbinate cluster 2 cm. or less in height, much exceeded by its lowest bract; perianth 3 to 4 mm. long, its parts equal, ovate-lanceolate, acute, with green or at maturity stramineous midrib and a brown stripe on either side; stamens 6, about one-half as long as the perianth, the anthers shorter than their filaments; capsule oblong, equaling the perianth, retuse, completely 3-celled; seed light brown, obovoid or oblong, .45 to .6 mm. in length, with oblique white apiculations connected by a usually evident white raphe, finely reticulated in about 16 longitudinal rows, the areolæ smooth and 2 to 4 times broader than long.

Type specimen in the U. S. National Herbarium, collected September 6, 1890, in an irrigated meadow, North Park, Colorado, by C. S. Crandall.

Other specimens beside the type have been examined as follows:

Colorado: Grand Lake, George Vasey, 1868, No. 576.

Wyoming: Sherman, altitude 8,000 feet, G. W. Letterman, July 28, 1884.
Big Horn Mountains, B. C. Buffum, August 6, 1892.
Clarks Fork Valley, J. N. Rose, September 3, 1893, No. 530.
Steamboat Point, Yellowstone Lake, Robert Adams, August 19, 1871.

Montana: Spanish Creek, P. A. Rydberg, July 11, 1896, No. 3058.
In a meadow, Spanish Basin, altitude 1,800 meters, P. A. Rydberg, July 17, 1896, No. 3116.
In a wet meadow, Blackhawk, P. A. Rydberg, August 5, 1896, No. 3282.

Idaho: In the vicinity of Forest and about Lake Waha, Nez Perces County, Mr. and Mrs. A. A. Heller, June 25, 1896, No. 3319, and July 16, 1896, No. 3446.

Washington: Near Spangle, Spokane County, W. N. Suksdorf, June 30, 1884, No. 1042.

Juncus confusus is one of seven closely related species, all of which with the exception of *J. tenuis* occur only in America and with the additional exception of *J. dichotomus* only in North America. *Juncus tenuis* was formerly a very rare plant in Europe, but is now becoming widely disseminated there and in nearly all parts of the world, apparently by introduction from America. The following synopsis will be useful in distinguishing the species of the group:

SYNOPSIS OF *JUNCUS TENUIS* AND ITS ALLIES.

Leaf blade flat, but sometimes involute in drying.

Anthers much longer than their filaments......*J. georgianus* Coville.
A densely tufted plant, with long leaves, reaching the unusually large inflorescence; brown-striped perianth 4 to 6 mm. long; and narrowly oblong-lanceolate completely 3-celled capsule. This species is known only from Georgia, where it occurs on Stone Mountain and adjacent knobs of similar geological structure. For full description see Bull. Torr. Club, **22**: 44. 1895.

Anthers not exceeding their filaments.

Perianth 2.5 to 4 mm. long, usually with some reddish or brownish coloration, equaling the completely 3-celled capsule; apex of the capsule distinctly triquetrous, truncate or retuse.

Inflorescence somewhat congested, much exceeded by its lowest involucral bract................*J. confusus* Coville.

A plant of the Rocky Mountain region from Colorado northward to Montana, Idaho, and Washington.

Inflorescence not congested, the flowers secund on the somewhat incurved branches, seldom exceeded by the lowest involucral bract......................*J. secundus* Beauv.

A species of common occurrence in the coastal plain from New Jersey to North Carolina and occasional in Illinois and Missouri.

Perianth 3.5 to 5.5 mm. long, green or stramineous, without brown stripes along either side of the midrib (except in the variety); capsule obovate, broadly rounded, though sometimes retuse, incompletely 3-celled........ ....*J. tenuis* Willd.

Occurring almost throughout North America, especially as a weed along roadsides and paths, and now migrating to all parts of the world. Along the Pacific coast from middle California to Vancouver Island occurs a robust variety with congested inflorescence much exceeded, as is usually the case also in the type form of the species, by the lowest involucral bract; the perianth 4 to 5.5 mm. in length, about one-half longer than the capsule; its parts with a reddish brown stripe along either side of the midrib. This plant is here named **Junctus tenuis occidentalis** (*J. tenuis congestus* Engelm. Trans. St. Louis Acad. **2**: 450. 1866. Not *J. congestus* Thuill. 1799).

Leaf blade terete, channeled along the upper side.

Seed not caudate.

Perianth 3.5 to 5 mm. long, not exceeded by the capsule. *J. dichotomus* Ell.

A species common to North and South America, occurring abundantly in the United States along the coast from Texas to New Jersey, and more rarely as far northward as Maine. The plant is often confounded with *J. tenuis* when not critically examined, but in addition to its leaf character it may be distinguished also by its darker green color and its fewer-ribbed (about 14 instead of 20 to 24) seeds.

Perianth 2.5 to 3 mm. long, conspicuously exceeded by the capsule..............................*J. greenei* Oakes & Tuckerm.

Occurring near the coast from New Jersey northward to New Brunswick; in Michigan, Wisconsin, and Minnesota; and in the Canadian province of Ontario. The inflorescence is usually short, much exceeded by the lowest involucral bract, and the exposed portions of the completely 3-celled ovoid-lanceolate capsule are commonly brownish. The seeds are commonly but erroneously described as caudate.

Seed distinctly caudate........................*J. vaseyi* Engelm.

Occurring from Michigan, Illinois, and Iowa northward to the plains of middle Canada; at Orono, Maine; in the Black Hills of South Dakota; and, on the authority of a label in the Canby Herbarium, in Middle Park, Colorado. *J. vaseyi* differs from the last, in addition to its important seed and perianth characters, in its inflorescence usually exceeding the lowest involucral bract, and the green, or, at maturity, stramineous capsule being little or not at all contracted toward the apex.

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PROCEEDINGS

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RIBES ERYTHROCARPUM, A NEW CURRANT FROM THE VICINITY OF CRATER LAKE, OREGON.

BY FREDERICK V. COVILLE.

Crater Lake is a remarkable body of the purest water, nearly circular in form, about ten kilometers (6 miles) in diameter and 600 meters (2,000 feet) in depth, without a visible outlet, occupying the bowl of an extinct volcano in the southern part of the Cascade Mountains of Oregon, situated about latitude 43° and longitude 122°. The surface of the water has an altitude of 1,902 meters (6,239 feet) and the surrounding cliffs rise 300 to 450 meters (1,000 to 1,500 feet) higher, some of the neighboring peaks reaching 2,400 and 2,700 meters (8,000 and 9,000 feet). The mountain slopes are densely forested, except where the trees have been burned off by sheep herders, and no settlements occur nearer than the plains below. It was the writer's good fortune to visit the place in August of the present year, at the time of the excursion of the Mazamas to that point. The Mazamas are an organization of mountain climbers, which originated in Portland, Oregon, and are doing a great deal to popularize the natural sciences, to make known the wonderful scenery of the Northwest coast, and especially to create and maintain a public sentiment toward the preservation of the magnificent forests of that region.

Nothing seems to have been published on the botany of this part of the Cascades, and indeed no botanist appears heretofore to have made a collection of the plants of the Crater Lake region. The collection made by the writer and Mr. John B. Leiberg from August 13th to 20th of the present year is therefore of unusual interest. Only a partial examination of the specimens has been made thus far, and a full report must be deferred, but an interesting species, apparently undescribed, is here presented to the public.

Ribes erythrocarpum Coville & Leiberg, sp. nov.

Shrub trailing upon the ground, devoid of prickles, the stems rooting and giving rise to ascending branches commonly 10 to 20 cm. in height, the herbage and inflorescence clothed with short glandular hairs; leaves angulate-orbicular in outline, rugose, commonly 2 to 3.5 cm. in diameter, on petioles nearly as long, 3 to 5-lobed, the sinuses extending one-half or two-thirds the way to the base, the lobes coarsely crenate and the crenatures unevenly but finely dentate-serrate; racemes erect, commonly 10 to 20-flowered, the bracts herbaceous, lanceolate to obovate, commonly 2 to 4 mm. long, persistent; flowers erect, contiguous, when expanded 6 to 8 mm. in diameter, on pedicels equaling the bracts; ovary beset with short glandular hairs; calyx not produced into a tube, the spreading lobes oblong, obtuse or broadly acute, yellow, minutely dotted with red, therefore appearing salmon-colored, sparingly and minutely pubescent without, glabrous within; petals broadly spatulate, glabrous, one-third to one-half the length of the calyx lobes and similar in color; filaments glabrous; style glabrous, 2-parted; fruiting racemes erect or sometimes declined by the weight of the berries; fruit on erect pedicels, scarlet, subpyriform to spherical, commonly 8 to 10 mm. in length, provided with short glandular hairs, the flesh white or translucent, insipid.

Type specimen in the United States National Herbarium, collected August 12, 1896, at an altitude of about 1,675 meters, in the canyon of Pole Bridge Creek, about 10 kilometers south of Crater Lake, Cascade Mountains, Oregon, by Frederick V. Coville and John B. Leiberg.

The plant appears from the structure of its flowers to be most nearly related to the *Ribes laxiflorum* of Pursh and the *Ribes howellii* of Greene (*R. acerifolium* Howell), from both of which it is at once distinguishable by its creeping habit and its glandular pubescence, in the latter of these characters and in its general appearance closely resembling Pursh's *Ribes viscosissimum.* Its herbage, however, possesses the rank odor of *Ribes prostratum* and *R. hudsonianum*, quite distinct from the citronella-like smell of *viscosissimum.* That species, too, has blue fruit and an elongated calyx tube. *Ribes erythrocarpum* grows in abundance about Crater Lake, in the forests of *Tsuga pattoniana*, to an altitude of at least 2,400 meters.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

AN UNDESCRIBED SHREW OF THE GENUS *SOREX*.

BY CHARLES F. BATCHELDER.

On September 9, 1895, at Beede's, Essex county, New York, I obtained a Shrew unlike any species known to me. It was caught in one of several 'cyclone' traps, baited with rolled oatmeal, that were set among some large, angular rocks at the head of a wooded talus of loose rock. Just above, shading the spot and keeping it moist and cool, rise the low cliffs from whose fragments the talus has been formed.

Nearly a year later, on August 1, 1896, I caught a second specimen of this Shrew on Mount Marcy, the highest of the Adirondack Mountains. It, too, was caught with oatmeal in a 'cyclone' trap. It was taken in a crevice between some rocks, on the bare, open summit of the mountain, about 5300 feet above sea-level. The locality where the first one was captured is about eight miles distant, in an air line, and lies at an elevation of only 1300 feet above the sea.

I have compared this Shrew with other species of the genus *Sorex* (the material for comparison I owe in some cases to the unfailing kindness of Dr. C. Hart Merriam), and find it so different from them all that I am led to describe it as follows:

Sorex macrurus sp. nov.

Type from Beede's [sometimes called Keene Heights], in the township of Keene, Essex county, New York; taken September 9, 1895. The type is a young adult male, No. 1384, collection of C. F. Batchelder.

General characters.—Size large; tail long; body stout.

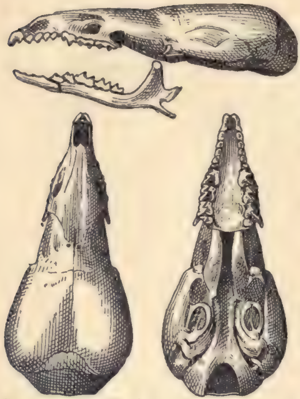

FIG. 26.—Skull of *Sorex macrurus* ♂ Type (× 2).

Colors (of type, noted in the flesh).—Upper parts between 'slate-color'[1] and 'blackish slate';[1] under parts dark 'smoke gray'[2] or brownish 'mouse-gray';[3] tail, above, browner than back; edge of lips and under side of tail, brownish flesh color; upper side of both hind and fore feet between 'fawn-color'[4] and 'ecru drab.'[4]

The specimen from Mt. Marcy (♂, ad. Aug. 1, 1896, No. 1386, coll. C. F. B.) differs in color from the type only in having a slightly more plumbeous tint, a difference due, apparently, merely to its pelage having been exposed to several weeks less wear.

Cranial and dental characters.—Skull long and slender; brain-case low, narrow, and little inflated; rostrum long, narrow, and low; palate rather narrow. Posterior border of infraorbital foramen lying over a point considerably behind the interspace between the first and second molars. Unicuspidate teeth slender; the first and second about equal in size; the third and fourth smaller, and subequal—if anything, the third slightly shorter than the fourth. Molariform teeth deeply excavated posteriorly.

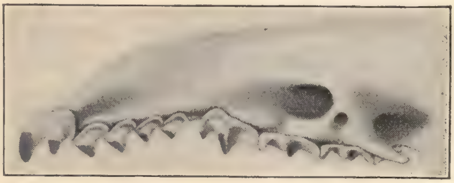

FIG. 27.—Left side of upper jaw showing teeth. Type (× 6).

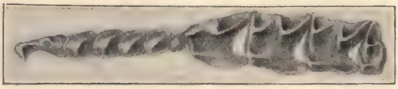

FIG. 28.—Same tooth row, seen from below.

Measurements (of type, taken in the flesh).—Total length, 130 mm.; tail vertebræ, 60 mm.; hind foot, 15 mm.; fore foot, 8 mm.; height of ear, 10 mm. The Mount Marcy specimen measured: total length, 139 mm.; tail vertebræ, 61 mm.; hind foot, 15 mm.; ear, 10 mm. The extreme tip of its tail appears to have been lost by some accident.

This Shrew differs so widely from all others with which I am acquainted that comparisons with any other species are quite unnecessary. In color and size it bears a slight superficial resemblance to *Sorex fumeus* and to *S. trowbridgii*, but it is at once distinguishable from them by its long tail, even without reference to its cranial and dental characters, in which it is totally unlike these species. In the general shape of the skull there is a suggestion of *Sorex personatus*, but in this respect *macrurus* is even more remote from such species as *trowbridgii* or *fumeus* than is *personatus* itself.

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[1] Ridgway: A nomenclature of colors for naturalists, etc., 1886, plate II, Figs. 4–3. [2] Ibid., Fig. 12. [3] Ibid., Fig. 11. [4] Ibid., pl. III, Figs. 22–21.

VOL. X, PP. 135-138 DECEMBER 28, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

SOME NEW MAMMALS FROM INDIAN TERRITORY AND MISSOURI.

BY OUTRAM BANGS.

In the summer of 1896 Mr. Thaddeus Surber undertook a collecting trip to Indian Territory in the interests of the Bangs collection. After spending a short time in Missouri he went to Stilwell, in the Cherokee Nation, at the northwest part of the Boston Mountains. The country was suffering from an unprecedented drought and all mammals were extremely hard to find. Mr. Surber was also handicapped by the unfriendliness of the Indians, who absolutely refused to help him in any way. He had collected but a few days when he was taken ill with an extremely malignant form of malaria, which compelled him to abandon the work.

The Boston Mountains about Stilwell rise to a height of 2,500 feet (estimated), and are closed in by ranges of low lying hills, some 250 or 300 feet higher than the intervening narrow valleys of rich land. Beyond the hills west of Stilwell stretches a barren prairie that is said to have been formerly forest-covered. On the sides of the mountains are found black walnut, white oak, red oak, black jack, etc., but no pines. The mountains all top off in cliffs from five to fifty feet high, composed of sandstone or bastard limestone, in which there are many caves.

The material collected at Stilwell, while small in number of specimens, is of great interest. Besides the new forms here described, Mr. Surber got only three species of mammals—the raccoon, *Procyon lotor;* the southern gray squirrel, *Sciurus carolinensis*, and the plains wood rat, *Neotoma baileyi.*

My thanks are due to General Nelson A. Miles, who with great kindness secured for me the necessary permit allowing Mr. Surber to collect in Indian Territory. I am also indebted to Dr. J. A. Allen for presenting me with specimens of *Lepus sylvaticus bachmani*, *Peromyscus attwateri*, and *Scalops texanus* for comparison with the Indian Territory forms.

Lepus sylvaticus alacer subsp. nov.

Type from Stilwell, Indian Ter., No. 5480, ♀ young adult, collection of E. A. and O. Bangs. Collected by Thaddeus Surber August 14, 1896. Original No. 65.

Two specimens from Stilwell, Indian Ter.; 2 from Stotesbury, Vernon Co., Mo.

General characters.—About the size of *Lepus sylvaticus bachmani*, but differing from that form in being much darker and richer in color and in having much smaller audital bullæ.

Color.—Type in summer pelage: upper parts rich reddish brown (about hazel), many of the hairs with black tips; nuchal patch and upper surface of legs and arms cinnamon rufous; sides and rump paler, shading towards wood brown; band on under side of neck wood brown; rest of under parts, including chin and throat, white. A specimen from Stotesbury, Mo., in winter pelage (No. 1677, February 27, 1894): upper parts cinnamon rufous on back, wood brown on sides, very thickly mixed with black-tipped hairs, giving a dark and rich effect; ears wood brown broadly edged with black; no black mark between ears.

Cranial characters.—Skull small, about the size of that of *L. sylvaticus bachmani*, differing from other members of the *sylvaticus* series in having extremely small audital bullæ. Size of type skull: basilar length, 536; occipitonasal length, 67.2; zygomatic breadth, 34; greatest length of single half of mandible, 51.6.

Size.—Type: total length, 370; tail vertebræ, 50; hind foot, 95; ear, 73. Average measurements of two adult specimens from Stotesbury, Vernon Co., Mo.: total length, 398; tail vertebræ, 30.5; hind foot, 79.35; ear, 82.6.

General remarks.—When I was at work on the cotton-tails of eastern North America in 1894 I had the two specimens referred to above, collected at Stotesbury, Mo., in the winter of 1894, by Mr. Surber, and on account of their small size, peculiar coloration, and small audital bullæ was unable to refer them to any known subspecies. They clearly belong to the same form as the Indian Territory specimens, which appears to be unnamed. The two examples taken at Stilwell were both shot in the low. rich valleys, and Mr. Surber did not find the animal on the mountains. This form probably has an extensive range throughout the region where the wooded eastern country meets the great plains.

Lepus sylvaticus alacer probably merges into *L. sylvaticus bachmani* of Texas, but its smaller audital bullæ and dark color at once distinguish it from the gray *bachmani*.

Peromyscus bellus sp. nov.

Type from Stilwell, I. T. No. 5483, ♀ adult, collection of E. A. and O. Bangs. Collected by Thaddeus Surber August 15, 1896. Original No. 67. Two specimens from Stilwell, I. T.

General characters.—Compared with *P. attwateri* (apparently its nearest geographical ally) *P. bellus* differs in being much darker and browner; in having a larger hind foot, a pectoral band of fawn color, and a fawn-colored nose patch (white in *attwateri*). It belongs to the group of so-called brush mice.

Color.—Upper parts broccoli-brown much mixed with black along back, becoming fawn color on lower sides; patch at root of whiskers fawn color; ears large, nearly naked, dusky; tail large and long, bicolored, black above, white below, well haired and with a decided pencil; feet and hands white; under parts white, the hairs plumbeous at base; a band of fawn color extending across under side of neck in front of arms.

Cranial characters.—Skull of the same general appearance as that of *P. attwateri*, but larger and with deeper, broader brain case. Size of the type skull: basilar length, 24.2; occipitonasal length, 28; zygomatic breadth, 14; greatest length of single half of mandible, 15.

Size.—Type: total length, 190; tail vertebræ, 90; hind foot, 24; ear, 17. Average measurements of two adult specimens from Stilwell, I. T.: total length, 192.5; tail vertebræ, 93.5; hind foot, 24; ear, 16.

General remarks.—The two examples of this brush mouse were taken on one of the rocky hillsides at Stilwell. *P. bellus* differs from *P. attwateri* very materially, but *P. attwateri* seems very close, perhaps too close, to *P. rowleyi*, as I must confess I can hardly distinguish skins of the two species.

Tamias striatus venustus subsp. nov.

Type from Stilwell, I. T. No. 5478, ♂ old adult, collection of E. A. and O. Bangs. Collected by Thaddeus Surber August 13, 1896. Original No. 63. Two specimens from Stilwell, I. T.; 1 from Noel, Mo.

General characters.—Size and proportions about as in *T. striatus griseus;* colors very bright, especially on rump; all the black dorsal and lateral bands much shortened; hair, especially on rump, hispid, but this character may be seasonal.

Color.—Rump and upper surface of legs deep, rich, lustrous chestnut rufous, this color extending up back and sides, narrowly bordering the black bands; sides yellowish gray; back (between the black bands) and upper neck and shoulders dark gray; ears and face much suffused with chestnut rufous; facial markings not conspicuous; hairs of upper surface of tail yellowish at base, then black and slightly tipped with white; under parts yellowish white, somewhat washed on belly and under side of legs with cinnamon rufous; under side of tail cinnamon rufous.

Cranial characters.—The skull is large, about as in *T. striatus griseus.* Size of type skull: basilar length, 38.6; occipitonasal length, 43.6; zygomatic breadth, 24.4; greatest length of single half of mandible, 26.2.

Size.—The type: total length, 260; tail vertebræ, 100; hind foot, 37. Size of No. 5605, ♂ adult from Noel, Mo.: total length, 255; tail vertebræ, 105; hind foot, 36.5.

General remarks.—The two specimens of this fine chipmunk that Mr. Surber got at Stilwell were shot at the edge of an old field well up on a hillside. The specimen from Noel, Mo., was taken in a similar place.

Tamias striatus venustus is by far the handsomest of the *striatus* series and is easily distinguished from any of the other subspecies. Its large size and big hind foot place it nearest to *griseus*, but its bright, rich coloration will at once separate it from that form. With the pale yellow *lysteri* of the northeast it needs no comparison, and from the small, dull, dark-colored true *striatus* of the southeast it can always be told by its larger size, bigger hind foot, longer tail, and much brighter coloration.

Scalops texanus æreus subsp. nov.

Type from Stilwell, I. T. No. 5475, ♀ old adult, collection of E. A. and O. Bangs. Collected by Thaddeus Surber, August 13, 1896. One specimen from Stilwell, I. T.

General characters.—Size larger than typical *S. texanus*; hind foot larger; colors darker, without orange markings about nose and chest; skull slightly different.

Color.—Rich coppery chestnut all over, without golden or orange suffusions; slightly duller below than above, and grayer on chin and throat.

Cranial characters.—The skull of *S. texanus æreus* as compared with that of true *texanus* is larger and of a slightly different shape. The skull of *texanus* has a short rostrum and is much bulged between the orbits. The skull of *æreus* has a longer rostrum and does not present the bulged appearance between the orbits. Size of type skull: basilar length, 28.4; occipitonasal length, 33.4; zygomatic breadth, 15.2; greatest length of single half of mandible, 21.8.

Size.—The type: total length, 154; tail vertebræ, 24; hind foot, 19.

General remarks.—Mr. Surber caught the type specimen of *Scalops texanus æreus* while it was engaged in tunneling on a black-jack ridge at Stilwell.

Dr. J. A. Allen* gives the following measurements for *Scalops texanus* from Rockport, Texas: Average of twelve adult males, total length, 141; tail vertebræ, 25; hind foot, 17.8; and of eight adult females, total length, 137; tail vertebræ, 23; hind foot, 16.5. The largest male measured: total length, 147; tail vertebræ, 27; hind foot, 19; and the largest female: total length, 146; tail vertebræ, 25.5; hind foot, 18. Although Dr. Allen gives no cranial characters for the species, the two skulls of *texanus* that I have examined can be easily told from either the skulls of typical *Scalops aquaticus* or *S. aquaticus argentatus*, apart from the smaller size, by the much shorter rostrum and bulging interorbital region. The skull of *æreus* is much more like that of *aquaticus*.

Mr. Surber took a fine series of *Scalops aquaticus argentatus* at Stotesbury, Vernon County, Mo., which brings the range of that subspecies very near the range of *S. texanus æreus*. *Æreus*, however, does not approach *argentatus* in any way, its affinities lying wholly with *texanus*.

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*Bull. Am. Mus. Nat. Hist., vol. vi, 1894, p. 186.

VOL. X, PP. 139-144 DECEMBER 28, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

THE SKUNKS OF THE GENUS *MEPHITIS* OF EASTERN NORTH AMERICA.

BY OUTRAM BANGS.

In 1895* I described a new skunk from Florida as a subspecies of the northern *Mephitis mephitica* (Shaw), and at the same time reviewed, in rather an informal way, the eastern members of the genus *Mephitis*. Since then I have learned more about the distribution of the eastern skunks and have seen many additional specimens, so that some of my former views have changed. I now consider the Florida *elongata* entitled to specific rank, and still another form from the Mississippi Valley entitled to recognition. The latter form, which I shall call *Mephitis mephitica scrutator*, is common in the pine and prairie region of central Louisiana, and extends northward up the Mississippi Valley and eastward through the Alleghany Mountains, gradually shading into true *mephitica*. Specimens from the central region from Virginia to Maine are typical of neither form. *M. mephitica typica* occurs only in high Canadian and Hudsonian regions. *M. elongata* is abundant, though locally distributed, over the greater part of peninsular Florida and extends up the Atlantic coast at least to southern South Carolina or northern Georgia, where it gradually ceases, and *no skunk* is found throughout eastern North Carolina,† thus leaving *elongata* and *mephitica* separated by a wide area in the east. Just what forms the western limit of the range of *M. elongata* I am unable to say, but probably it is the heavy swamps of the lower Mississippi.

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*Notes on North American Mammals, Proc. Boston Soc. Nat. Hist., vol. xxvi, author's edition, July 31, 1895.

† Messrs. H. H. and C. S. Brimley, in fourteen years of constant collecting about Raleigh, N. C., have never seen a skunk there, and have only known one to be reported as having been killed. I have made many inquiries of farmers throughout eastern North Carolina and have always got the same answer, that there are no skunks there. Of course, *elongata* or *mephitica* might be expected to occur occasionally as stragglers.

MEPHITIS MEPHITICA (Shaw).

1792. *Viverra mephitica* Shaw, Museum Leverianum, 1792, p. 172.
1857. *Mephitis mephitica* Baird, Mamm. N. Am., 1857, p. 195.

Geographic distribution.—Whole of eastern North America from Ontario, Quebec, and Nova Scotia to Louisiana, except Florida and the coast belt from thence to Virginia. Its range may overlap that of *M. elongata* in the lower Mississippi Valley, and undoubtedly does overlap the range of *M. hudsonica* * in the upper Mississippi Valley.

Description.—Size small to medium; tail short to medium, tapering to a pencil; color pattern variable, but usually black all over except frontal stripe, nuchal patch, two strips extending from nuchal patch to and down sides of tail, tip of tail and some scattered hairs in black part of tail, all of which are white.

Fully adult males vary in size according to locality: total length, 595–682; tail vertebræ, 171–241; hind foot, 64–83.

M. mephitica is distinguished from *M. hudsonica* by smaller size, shorter tail, tapering to a pencil, and smaller and less elongated skull. It is separated from *M. elongata* by heavier build, much shorter tail, and proportionally shorter and broader hind foot.

This species may be divided into two well-marked subspecies, *Mephitis mephitica mephitica* and *M. mephitica scrutator.*

Mephitis mephitica mephitica (Shaw).

1792. *Viverra mephitica* Shaw, Museum Leverianum, 1792, p. 172.
1895. *Mephitis mephitica* Bangs, Proc. Boston Soc. Nat. Hist., Vol. XXVI. Author's edition, July 31, 1895. (Name restricted to the Hudsonian form.)

Type locality.—North America.

Geographic distribution.—Boreal eastern North America; Nova Scotia, Quebec, and Ontario south to about the northern limits of the United States. Western limit of range unknown.

General characters.—Size large; tail short, tapering off to a pencil; feet very broad and long; heel usually covered with hair, rest of sole naked;

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* *Mephitis hudsonica* (Richardson) extends eastward to Minnesota and probably to western Ontario. It is a very big skunk, fully adult males measuring: total length, 690; tail vertebræ, 255; hind foot, 83, and larger. The skull is large and long and the dentition heavy. The palate ends in an even curve, without median spine. The color pattern varies but little. The tail is long, very heavily haired, and has a blunt brush-like end, around which the long hairs of the sides of the tail fall.

markings very constant, varying only in a trifling difference of length and width of the two lateral white stripes.

Color.—A narrow frontal stripe, nuchal patch, and two lateral bands extending from nuchal patch to and down sides of tail, white; tip of tail often white; many white or half white hairs mixed in tail; rest of head, body, tail, arms, and legs, black. Varies in a slight degree only. Occasionally the white stripes reach only to the middle of sides of back; the stripes vary in width but little.

Cranial characters.—Skull large and massive, the palate ending in an even curve, without median spine. Size of an old adult male skull (No. 3805, Bangs collection from Lake Edward, Quebec): basilar length, 71.6; occipitonasal length, 74.6; zygomatic breadth, 52; mastoid breadth, 43.8; greatest length of single half of mandible, 52.8. Size of an old adult female skull (No. 3802, Bangs coll. from Lake Edward, Quebec): basilar length, 65.2; occipitonasal length, 67.2; zygomatic breadth, 47.6; mastoid breadth, 40.8; greatest length of single half of mandible, 50.

Size.—Old adult ♂ (No. 2022, Bangs coll. from Digby, Nova Scotia): total length, 682; tail vertebræ, 171; hind foot, 83. Old adult ♀ (No. 3802, Bangs coll. from Lake Edward, Quebec): total length, 565; tail vertebræ, 159; hind foot, 75.

General remarks.—The constancy of the markings of *Mephitis mephitica typica* and the absence of the median spine of the palate are both characters it possesses in common with the big-tailed western species of the *hudsonica* group, from which it differs, however, in its shorter tail, tapering to a pencil, and its smaller size. Its range is very restricted. In its extreme form it occurs only in a narrow belt, including the upper edge of the Canadian and lower edge of the Hudsonian zones. Its exact northern limit is unknown to me, but the evidence seems to indicate that it does not reach very far north. A long line of intermediates extends southward from northern Maine until the other extreme, *M. m. scrutator*, is reached in the lower Mississippi Valley.

Mephitis mephitica scrutator subsp. nov.

Type from Cartville, Acadia Parish, Louisiana. No. 2889, ♂ old adult, collection of E. A. and O. Bangs. Collected by F. L. Small May 25, 1895. Original No. 1842.

Geographic distribution.—Pine and prairie regions of central Louisiana, extending up the Mississippi Valley to Indiana and eastward across the Alleghanies to Virginia, and thence northward, gradually becoming less typical, until it merges into true *mephitica*.

General characters.—Size small; tail medium (actually longer than in *mephitica typica*), tapering off to a pencil; feet very small; markings very variable.

Color.—Color and markings as in true *mephitica*, but much more variable. The two lateral white stripes are often so wide as to meet on the back for nearly their whole length, forming the predominating color of the upper parts. In other specimens the lateral stripes are reduced to two small points of white projecting backward from the nuchal patch, the rest of the upper parts, except the frontal stripe and nuchal patch, being black.

Cranial characters.—Skull much smaller and lighter than that of *M. mephitica typica;* palate ending in a median spine, not always large, but even when much reduced giving a very different outline to end of palate from that of *mephitica typica.* Size of the type skull (an old adult ♂): basilar length, 60; occipitonasal length, 63.2; zygomatic breadth, 44; mastoid breadth, 35; greatest length of single half of mandible, 45.6. An old adult ♀ (No. 2886, Bangs collection from Point aux Loups Springs, Acadia Parish, La.): basilar length, 57.4; occipitonasal length, 62.2; zygomatic breadth, 38.8; mastoid breadth, 35; greatest length of single half of mandible, 43.

Size.—Old adult ♂ type: total length, 580; tail vertebræ, 208; hind foot, 64. Old adult ♀ (No. 2886, Bangs coll., from Point aux Loups Springs, Acadia Parish, La.): total length, 594; tail vertebræ, 233; hind foot, 67.

General remarks.—Among the intergrades between this form and *mephitica typica* that occur through the New England and Middle States, but especially northward, examples can be found both with and without the median spine at the end of the palate. No specimen that I have ever seen of *Mephitis mephitica typica*, however, has shown any approach to such a spine, not even the very young examples, while it is present, in a varying degree, in every skull of *scrutator* examined.

MEPHITIS ELONGATA Bangs.

1895. *Mephitis mephitica elongata* Bangs, Proc. Boston Soc. Nat. Hist., Vol. XXVI. Author's edition, July 31, 1895, p. 3.

Type locality.—Micco, Brevard Co., Florida.

Geographic distribution.—Peninsular Florida, north along the coast to southern South Carolina; western limit of range unknown. Rare in the northern part of its range; locally distributed everywhere.

General characters.—Size large, but of lighter build than *M. mephitica;* tail very long, tapering to a pencil; feet very long and slender; color and markings very variable.

Color.—Color and markings as in *Mephitis mephitica scrutator* and subject to the same range of individual variation. One specimen is all black except the tip of the tail and the nuchal patch, even the usual white frontal stripe being entirely wanting. Another has most of the tail and the whole back, except a narrow median line on the rump, white.

Cranial characters.—Skull large, about the size of that of *Mephitis mephitica typica*, always with a large median spine at end of palate.

Size of an old adult ♂ skull (No. 3052, Bangs coll., topotype): basilar length, 66.4; occipitonasal length, 71; zygomatic breadth, 49.2; mastoid breadth, 40; greatest length of single half of mandible, 50.8. An old adult ♀ skull (No. 2484, Bangs coll., from Blitches Ferry, Citrus Co., Fla.): basilar length, 59.6; occipitonasal length, 62.2; zygomatic breadth, 45.4; mastoid breadth, 35.8; greatest length of single half of mandible, 46.4.

Size.—Old adult ♂ (topotype, No. 3052, Bangs coll.): total length, 719; tail vertebræ, 321; hind foot, 76. An old adult ♀ (No. 2483, Bangs coll., from Blitches Ferry, Citrus Co., Fla.): total length, 673; tail vertebræ, 330; hind foot, 70.

General remarks.—*Mephitis elongata* is very different from *M. mephitica*, and its characters are constant throughout its range. Since I can find no indication of intergradation and the ranges of the two forms are separated, at least in the east, by a strip of neutral ground, where no skunk occurs, *M. elongata* seems entitled to rank as a full species.

(*Measurements on next page.*)

Individual Measurements of a Series of Eastern Skunks (genus Mephitis).

Number.	Locality.	Sex.	Age.	Total length.	Tail vertebræ.	Hind foot.	Measured by—
	Mephitis mephitica mephitica (Shaw).						
3801*	Quebec, Lake Edward	♂	Old adult	585.0	193.0	75.0	O. Bangs.
3803	“ “ “	♂	Adult	617.0	182.0	79.0	“ “
3804	“ “ “	♂	Adult	592.0	182.0	76.0	“ “
3802	“ “ “	♀	Old adult	565.0	159.0	75.0	“ “
2022	Nova Scotia, Digby	♂	Old adult	682.0	171.0	83.0	“ “
2249	Nova Scotia, Annapolis	♂	Adult	635.0	226.0	78.0	“ “
3942†	Ontario, North Bay	♂	Old adult	600.0	170.0	80.0	G. S. Miller, Jr.
3941	“ “ “	♀	Old adult	590.0	170.0	65.0	“ “
3945	Ontario, Little Pick River	♂	Old adult	580.0	190.0	75.0	“ “
	Intermediates.						
2684*	Maine, Upton	♂	Old adult	660.0	280.0	70.0	James Bernier.
2683	“ “	♂	Old adult	612.0	217.0	68.0	“ “
2685	“ “	♂	Young adult	595.0	206.0	65.0	“ “
2686	“ “	♀	Young adult	625.0	209.0	70.0	“ “
2433	Maine, Bucksport	♀	Old adult	544.0	169.0	62.0	O. Bangs.
5450	Massachusetts, Wareham	♂	Old adult	622.0	220.0	68.0	“ “
1705	“ “	♂	Old adult	599.0	200.0	68.5	“ “
797	“ “	♂	Adult	573.0	225.0	66.0	“ “
5449	“ “	♂	Adult	569.0	199.0	63.0	“ “
1706	“ “	♀	Old adult	595.0	251.0	61.0	“ “
1709	“ “	♀	Adult	623.0	248.0	64.0	“ “
798	“ “	♀	Adult	584.0	242.0	63.0	“ “
1707	“ “	♀	Adult	572.0	244.0	61.0	“ “
2372	Connecticut, Liberty Hill	♂	Adult	591.0	239.0	63.0	“ “
2370	“ “ “	♀	Old adult	632.0	278.0	67.0	“ “
1050	“ “ “	♀	Adult	565.0	252.0	63.0	“ “
2416	“ “ “	♀	Adult	564.0	253.0	60.5	“ “
	Mephitis mephitica scrutator nov.						
2892	Louisiana, Point aux Loups Springs	♂	Old adult	595.0	241.0	64.0	F. L. Small.
2891	“ “ “ “ “	♂	Old adult	567.0	224.0	62.0	“ “
2890	“ “ “ “ “	♂	Old adult	563.0	219.0	62.0	“ “
2889	Louisiana, Cartville	♂	Adult	580.0	208.0	64.0	“ “
2886	Louisiana, Point aux Loups Springs	♀	Old adult	594.0	233.0	67.0	“ “
2887	“ “ “ “ “	♀	Adult	585.0	228.0	62.0	“ “
2888	Louisiana, Cartville	♀	Adult	518.0	210.0	56.0	“ “
	Mephitis elongata Bangs.						
3052	Florida, Micco	♂	Old adult	719.0	321.0	76.0	O. Bangs.
3051	“ “	♂	Young adult	686.0	312.0	72.0	“ “
2482	Florida, Blitches Ferry (Citrus County)	♂	Young adult	715.0	351.0	72.0	F. L. Small.
2483	“ “ “ “ “	♀	Old adult	673.0	330.0	70.0	“ “
5036	Georgia, St. Marys	♂	Young adult	629.0	290.0	75.0	O. Bangs.
5038	“ “	♀	Old adult	734.0	309.0	75.0	“ “
5037	“ “	♀	Adult	685.0	321.0	71.0	“ “

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* Collection of E. A. and O. Bangs, Boston, Massachusetts.

† Collection of Gerrit S. Miller, Jr., Peterboro, New York.

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PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

A REVIEW OF THE SQUIRRELS OF EASTERN NORTH AMERICA.

BY OUTRAM BANGS.

The present paper is intended to review briefly all the squirrels of the genera *Sciurus* and *Sciuropterus* known to occur in North America east of the great plains. It is based principally on material in the collection of E. A. and O. Bangs, but in addition to this my friends, Dr. C. Hart Merriam, Mr. Gerrit S. Miller, Jr., and Mr. Samuel N. Rhoads, have kindly lent me specimens from many localities of special interest. I have also, through the kindness of Mr. William Brewster, examined all the skins in the Museum of Comparative Zoölogy at Cambridge.

The last important work on our squirrels was Dr. J. A. Allen's Monograph of the Sciuridæ published in 1877. As in the light of more modern material some of the conclusions reached in that work must be changed and a few new forms added, it seems well to review the whole group, mapping out so far as possible the geographic distribution of each species and subspecies.

While all our squirrels tend to break off very readily into geographic forms, the gray squirrel (*Sciurus carolinensis*) presents the most remarkable case, since it is impossible to recognize less than five races of this most protean species.

There is an immense range of individual color variation in some of the species, particularly in the fox squirrels. The northern gray squirrel varies much and is so subject to melanism in certain localities that the black phase is commoner than the gray. In such localities all sorts of strangely colored partially melanistic individuals occur; on the other hand, over large areas of country the black phase is unknown. The red squirrel is not subject to melanism. I have heard of black individuals, but have never seen one. Local albinistic races or families are, however, not uncommon. One of these colonies is near Denver, Ind., from whence I have a curious series presenting every degree of albinism.

The flying squirrels do not vary individually to an extent worth notice.

The earlier writers were much troubled and confused by our squirrels, and as a consequence some of the species have an appalling array of synonyms. Professor Baird, in 1857, did a splendid piece of work, considering the scanty material he had, in doing away with most of the superfluous names, and Allen, twenty years later, put on a few finishing touches.

List of Species and Subspecies of Sciurus and Sciuropterus Inhabiting Eastern North America.

Name.	Type locality.
Sciurus niger Linn	Southern South Carolina.
ludovicianus Custis	Red River of Louisiana.
ludovicianus vicinus subsp. nov	White Sulphur Springs, W. Va.
carolinensis Gmelin	Carolina.
carolinensis leucotis (Gapper)	Region between York and Lake Simcoe, Ont.
carolinensis hypophæus Merriam	Elk River, Minn.
carolinensis fuliginosus (Bachman)	New Orleans, La.
carolinensis extimus subsp. nov.	Miami, Florida.
hudsonicus Erxl	Hudson Strait.
hudsonicus loquax subsp. nov	Liberty Hill, Conn.
Sciuropterus sabrinus (Shaw)	Severn River, James Bay.
silus sp. nov	Top of Katis Mtn., above White Sulphur Springs, W. Va.
volans (Linn.)	North America.
volans querceti subsp. nov	Citronelle, Citrus Co., Florida.

Genus SCIURUS Linnæus.

Tail long and bushy; ears well developed, sometimes slightly tufted; feet adapted for climbing, the anterior having four digits and a rudimentary pollex and the posterior five digits, all of which have long, curved, and sharp claws; mammæ from four to six; skull light built, with long postorbital processes; penultimate upper premolar, when present, minute; diurnal.*

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* Substantially taken from Flower and Lydekker, Mammals Living and Extinct, London, 1891.

Sciurus niger (Linn.). Southern Fox Squirrel.

1758. *Sciurus niger* Linn., Syst. Nat., ed. 10, I, 1758, p. 64 (based on Catesby's black fox squirrel); Allen, Monog. N. Am. Sciuridæ, 1877, p. 719.
1758. *Sciurus cinereus* Linn., Syst. Nat., ed. 10, I, 1758, p. 64 (in part).
1788. *Sciurus vulpinus* Gmelin, Syst. Nat., I, 1788, p. 147; Baird, Mamm. N. Am., 1857, p. 246.
1802. *Sciurus capistratus* Bosc, Ann. du Muséum, I, 1802, p. 281; Bachman, Proc. Zoöl. Soc. London, 1835, p. 85; Aud. and Bach., Quad. N. Am., II, 1851, p. 132, pl. LXVIII.*

Type locality.—Probably southern South Carolina; based on Catesby's black fox squirrel.

Geographic distribution.—From the southern limit of the pine forest in Florida north to Virginia; west about to eastern Louisiana in the south, and to the foot of the Alleghany Mountains in the north.

Habitat.—Wholly confined to the great pine forest of the South Atlantic and Gulf States; breeding in trees, often building its nest in the little cypress ponds so common in this region, living principally on the ground, and climbing trees, even when pursued, with apparent reluctance and in a heavy and clumsy manner.†

S. niger is still common over the greater part of its range, but is very shy, and is seldom seen unless one has a dog trained to hunt it.

General characters.—Size, largest of the eastern squirrels; color very variable, but nose and ears always white. Feet and hands very large, the soles naked in the adult, sometimes partially covered with soft downy hair in the young. Pelage coarse and harsh.

Color.—Nose and ears always white, even in the black individuals; rest of the pelage varying individually from uniform glossy black to clay color

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*I have refrained from giving any references to Gray's article on American squirrels entitled *Synopsis of the Species of American Squirrels in the Collection of the British Museum* (Annals and Magazine of Natural History, 3d series, vol. xx, 1867, p. 415), because the author seems to have had but a poor idea of the subject of which he treated, and any reference to his work must only lead to confusion. As an example, Gray puts *Sciurus niger* in F. Cuvier's genus *Macroxus*, under the name *Macroxus vulpinus* (in which genus he also puts the northern and southern gray squirrels), while he keeps the closely related species *S. cinereus* Linn. (= *S. ludovicianus vicinus* of the present paper) in the genus *Sciurus* with the red squirrels and *Sciurus aberti*, which he spells *alberti*. Gray fortunately only proposed three new names for eastern North American squirrels in this article. He renamed the northern and southern gray squirrels, calling the former *Sciurus carolinensis* var. *major* and the latter *Sciurus carolinensis* var. *minor*. The other name is *Macroxus neglectus*, from a specimen without locality, to which Gray assigns 'North America.' It is impossible to say from his description what this animal was, and it is very doubtful if it came from eastern North America.

† Its usual way of escape when chased is to run along the ground to some stump or log, upon which it climbs and waits until its pursuer comes too near, when it runs to another place of vantage, and so on. It takes to a tree only as a last resort, and then keeps to the trunk and large branches, trying to avoid detection by hiding. I believe it never jumps from tree to tree, as does its more agile and lightly built cousin, the gray squirrel.

mingled with black above (the hairs having either black tips or a black subapical band and clay-colored tips) and uniform clay color below. Tail usually mixed clay color and black (the hairs being clay color at base and tips and black in the middle) above and below. A few specimens have the under side of tail clear clay color. Top of head from white nose patch to ears usually black, even in the lightest examples. Occasional examples of a general ferruginous tone with the under side of tail rusty can be found in any large series.

Cranial characters.—Skull large and massive, developing with age conspicuous lateral ridges; rostrum long and well arched; ascending branches of premaxilla broad posteriorly, giving great breadth at the root of the zygomata; nasals broad and long, extending back of ascending branches of premaxilla; postorbital process of frontal heavy; ratio of occipitonasal length to nasal length, 30.78; penultimate upper premolar always absent in the adult. Size of an average adult skull: basilar length (basion to front of premaxilla), 64; occipitonasal length, 74.6; zygomatic breadth, 41; greatest height of cranium above palate, 22.6; greatest length of single half of mandible, 44.2.

Size.—Average measurements of fifteen adult specimens from Citronelle, Citrus Co., Fla.: total length, 638.46; tail, 304.13; hind foot, 87.81.

General remarks.—It does not seem probable that the black individuals of *Sciurus niger* are melanistic. They invariably retain the white ears and nose, and the commonest form has the back about half black, but the amount of black, as in the skunk, is very variable.

Sciurus niger retains its characters so constantly over the whole of its range and differs so markedly from the two smaller fox squirrels, *Sciurus ludovicianus* and *Sciurus ludovicianus vicinus*, that I treat it as a distinct species. Dr. Allen speaks of intermediate individuals from Virginia and Maryland, but I have never seen any such. The material at the time Dr. Allen's Monograph was written was of course very much inferior to that of today; consequently the differences between the species were not wholly apparent. Dr. Allen was, moreover, very badly off for skulls of any of the fox squirrels. I have but few specimens from localities where *S. niger* might be expected to actually interblend with either *S. ludovicianus* or *S. ludovicianus vicinus*, but such regions are small in extent, and it does not seem possible for animals as distinct as these to pass into each other suddenly.

Linnæus' *Sciurus niger*, as is well known, was based on the black fox squirrel of Catesby. Bachman applied this name to the melanistic variety of the northern gray squirrel, taking *Sciurus capistratus* Bosc for the fox squirrel. Professor Baird used the name *Sciurus vulpinus* Gmelin because Linnæus' name was given to the black variety only of the fox squirrel. Dr. Allen in 1877 restored *Sciurus niger* to its proper place, and the name has since then been generally used.

Specimens examined.—Total number, 44, from the following localities:

Florida: Hibernia, 1; Hawkinsville, 1; Citronelle, 37.
Georgia: St. Marys, 2; Columbus, 1.
North Carolina: Tarboro, 2.

Sciurus ludovicianus ludovicianus Custis. Western Fox Squirrel.

1806. *Sciurus ludovicianus* Custis, Barton's Med. and Phys. Journal, II, 1806, p. 43; Baird, Mamm. N. Am., 1857, p. 251.
1877. *Sciurus niger* var. *ludovicianus* Allen, Monog. N. Am. Sciuridæ, 1877, p. 720.
1822. *Sciurus rufiventer* "Geoff., Mus. Par.," Desmarest, Mamm., II, 1822, p. 332 (New Orleans); Harlan, Fauna Americana, 1825, p. 176; Schinz, Synop. Mamm., II, 1845–46. (Specimens from Missouri.)
1823. *Sciurus macroura* Say, Long's Expd. Rocky Mts., I, 1823, p. 115 (Kansas). Name preoccupied by Erxleben for a Ceylon species.
1825. *Sciurus magnicaudatus* Harlan, Fauna Amer., 1825, p. 178 (as a substitute for *S. macroura* Say).
1838. *Sciurus subauratus* Bach., Proc. Zoöl. Soc. London, 1838, p. 87.
1838. *Sciurus auduboni* Bach., Proc. Zoöl. Soc. London, 1838, p. 97.
1842. *Sciurus occidentalis* Aud. and Bach., Journ. Acad. Nat. Sciences, Phila., VIII, 1842, p. 317.
1851. *Sciurus rubicaudatus* Aud. and Bach., Quad. N. Am., II, 1851, p. 30, pl. LV.
1851. *Sciurus sayi* Aud. and Bach., Quad. N. Am., II, 1851, p. 274, pl. LXXXIX.

Type locality.—Red River of Louisiana.

Geographic distribution.—Mississippi Valley from Louisiana north to South Dakota; east probably to about the western edge of the Alleghany Mountains; west to the plains.*

Habitat.—Mixed forest and heavier woods, extending well into the prairies along the wooded streams. Still abundant over most of its range.

General characters.—Size much smaller than *Sciurus niger* (but little greater than the northern gray squirrel); ears and nose never white; colors very variable, but much deeper and more ferruginous than in the next subspecies, *S. ludovicianus vicinus;* feet of moderate size; soles often well clothed with hairs in winter; pelage in winter soft and full, with the ears well tufted.

Color.—Very variable, ranging from wholly black to a mixed black and rufous or ferruginous, the hairs being banded above, including the tail, and clear rufous or bright ferruginous below; most intense on ears, upper side of hands and feet, and on under side of tail. Some individuals have the under parts orange, some have the upper parts a pepper and salt mixture of yellowish and black and the under parts black.

Cranial characters.—Skull much smaller than that of *Sciurus niger*, which it resembles in general massiveness, but from which it differs in having proportionally a much shorter and blunter rostrum and shorter, broader nasals; ratio of occipitonasal to nasal length, 32.11; arrangement of teeth as in *S. niger*. Size of an average adult skull: basilar length, 55.2; occipitonasal length, 64.2; zygomatic breadth, 37.4; greatest height of cranium above palate, 20.4; greatest length of single half of mandible, 40.8.

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* Replaced in western Texas by a different subspecies, the small, pale *Sciurus ludovicianus limitis* (Baird). Type from Devils River, Texas.

Size.—Average measurements of fifteen adult specimens from Point aux Loups Springs, Acadia Parish, Louisiana: total length, 541.5; tail vertebræ, 252; hind foot, 73.7.

General remarks.—*Sciurus ludovicianus* is blessed with a greater number of synonyms than any other of our squirrels, owing to its enormous range of color variation, and to the fact that it occupies a large area of country. The so-called *Sciurus magnicaudatus* of Harlan, from the Missouri River region, will perhaps average a trifle smaller than Louisiana specimens, and, as a rule, is a little paler in color, but the differences are trifling and not worthy of subspecific recognition.

Specimens examined.—Total number, 44, from the following localities:

Louisiana: Point aux Loups Springs, Acadia Parish, 15; Grand Coteau, 2; Prairie Mer Rouge, 5.
Missouri: St. Louis, 3.
Indiana: Redfield,* 4; Denver, 1.
Illinois: Marion, 6; Jacksonville, 4; W. Northfield, 1.
Iowa: Sioux City, 1.
South Dakota: Richland, 2.

Sciurus ludovicianus vicinus subsp. nov. Northern Fox Squirrel.

1831. *Sciurus cinereus* Le Conte, Appendix to McMurtrie's Cuvier, 1831, p. 433; Bachman, Proc. Zoöl. Soc. London, 1838, p. 89; Aud. and Bach., Quad. N. Am., I, 1849, p. 145, pl. XVII; Baird, Mamm. N. Am., 1857, p. 248.
1877. *Sciurus niger* var. *cinereus* Allen, Monog. N. Am. Sciuridæ, 1877, p. 718.
1792. *Sciurus vulpinus* Schreber, Säugth., IV, 1792, p. 772. (Brought from Baltimore by Schoepf; name preoccupied by *S. vulpinus* Gmelin = *S. niger* Linn.). Not *Sciurus cinereus* Linn.

Type from White Sulphur Springs, W. Va. No. 5215, collection of E. A. and O. Bangs, ♀ old adult. Collected by Thaddeus Surber, January 29, 1896; total length, 582; tail, 282; hind foot, 75.

Geographic distribution.—From northern Virginia north, formerly to central New York and casually southern New England; west through West Virginia and Pennsylvania, probably extending some distance south in the Alleghany Mountains and higher land of Virginia and North Carolina. Now rare and local throughout its range.

Habitat.—The more heavily wooded and unsettled parts throughout its range, apparently fast becoming extirpated.†

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*Town not on modern maps; name appears on labels of specimens in Museum of Comparative Zoölogy.

†The Northern fox squirrel is one of the animals that cannot withstand persecution and the clearing and settlement of the country. It is already becoming very hard to get specimens of this subspecies. Dr. B. H. Warren, Zoölogist of the State of Pennsylvania, writes me that the northern fox squirrel is practically extinct in Pennsylvania except in the counties of Dauphin and Cumberland. I can get no information of any having been taken lately in New Jersey and fear it has met the same fate in that State. There seem to be a few left in the vicinity of the city of Washington. Mr. Vernon Bailey, in his 'List of the Mammals of the District of Colum-

General characters.—Size somewhat larger than *S. ludovicianus typicus.* General color usually less ferruginous, often yellowish gray; belly usually white and only under side of tail ferruginous; soles of feet naked in summer, partially covered with hair in winter; character of pelage the same as in true *ludovicianus.*

Color.—Ears never white; nose sometimes white; usual color of upper parts a mixed black and rusty, the hairs banded with black and pale ferruginous; under parts pale ferruginous to rusty white; under surface of tail ferruginous, the hairs with often a black subapical band. Ears ferruginous and in winter well tufted.

Some specimens are much lighter in color, being yellowish gray above, with the black banding of the hairs reduced to a minimum; the belly white, and the under surface of the tail pale ferruginous. Some others have a good deal of black on the head, belly, and legs, but I have never seen a wholly black individual.

Cranial characters.—Skull rather larger than that of *Sciurus ludovicianus;* otherwise similar. Ratio of occipitonasal length to nasal length, 32.3. Size of an average adult skull (the type): basilar length, 61; occipitonasal length, 68.8; zygomatic breadth, 40; greatest height of cranium above palate, 22.2; greatest length of single half of mandible, 42.2.

Size.—Average measurements of three adult specimens from White Sulphur Springs, W. Va.: total length, 587.7; tail vertebræ, 271.8; hind foot, 73.3.

General remarks.—It seems strange that among the multitude of names given our squirrels, and especially the fox squirrels, there should be none to apply to the present subspecies. Linnæus' name *Sciurus cinereus* has passed current for a long time for this animal, but cannot possibly apply to it. Linnæus based his name on three authorities, namely:

Ray's Quadrupeds, p. 215, "*Sciurus virginianus cinereus major.*"

Catesby's Natural History, II, p. 74, t. 74, "The Gray Fox Squirrel, *Sciurus cinereus.*"

Kalm, 2, p. 409.

Ray says of his *Sciurus virginianus cinereus major* that it is the size of the common rabbit (of Europe) and of the same color, and that it inhabits Virginia. This brief description can apply, on account of the very large size claimed for the species, to none other than the large southern fox squirrel, *Sciurus niger* Linn.

Catesby's gray fox squirrel has been supposed by subsequent authors, Baird excepted, to be the northern fox squirrel, but such a view seems to me wholly untenable and in direct contradiction to the evidence.

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bia,' records several specimens from Laurel, Md., in Dr. Merriam's collection, and states that many are shipped to Center Market from points in Virginia thirty or forty miles west of the city. The subspecies is, however, rare in most parts of northern Virginia. Lieut. Wirt Robinson has told me that in ten years' shooting in Buckingham County, Va., he got only two fox squirrels out of hundreds of squirrels killed. A few remain in the Alleghanies of West Virginia, where Mr. Thaddeus Surber got me three fine specimens in the last two years at White Sulphur Springs.

Catesby worked for the greater part of his stay in this country in a region in which the northern fox squirrel is unknown and in which the southern fox squirrel is abundant. Catesby spent one year on the coast, then went up the Savannah River to Fort Moore, about half way from the source of the river to the sea. It is true he made several expeditions into the mountains, and possibly may have seen the northern fox squirrel on some of these trips,* but if he did, he makes no mention of any such animal. He distinctly places his gray fox squirrel as an inhabitant of the coast region (a region wholly tenanted by the southern fox squirrel) by his remark that it, with the black fox squirrel, does great harm to the maize and pulse plantations of Virginia and Carolina (under descriptions of the two fox squirrels), he having previously stated that the inhabited portion of the country extended only sixty miles back from the coast (p. VIII, preface). Catesby's figure and description of the gray fox squirrel leave much to be desired, but one point upon which he was very careful in all his accounts of birds, mammals, and reptiles was size, and he distinctly states the gray and black fox squirrels to have been of about the same size (under description of black fox squirrel, Vol. II, p. 73). Judging by his work on other animals, Catesby would never have made such an assertion if he were describing the northern fox squirrel, an animal much smaller than the southern fox squirrel. Both on geographical and technical grounds it is impossible that Catesby's gray fox squirrel could have been intended for the northern fox squirrel, and his gray fox squirrel resolves itself into nothing more than the light colored phase of the southern fox squirrel, while his black fox squirrel is the black phase of the same species.

The black or nearly black individuals of the southern fox squirrel are much rarer than the light-colored ones, the proportion being about seven to one in favor of the light ones, and when the two extremes are compared they certainly look like very different animals, and are supposed so to be to this day by most southern squirrel-hunters. Catesby tells us that at first he judged the two to be one species, but finally yielded to the common notion and considered them distinct. (Under description of black fox squirrel.)

A point of some interest is that Catesby does not mention the gray squirrel (*Sciurus carolinensis* Gmelin) at all. It must certainly have been an abundant animal all about him, and it is probable that he confused it with the light-colored phase of the southern fox squirrel, perhaps thinking the ones he saw younger or smaller individuals of this kind.

Kalm gives a short but accurate description of the gray squirrel (*Sciurus carolinensis*), both as to size and color, as he saw it in Pennsylvania, and his long account of its habits, etc., refers to this species alone, he making no mention of any larger animal.

From the composite Linnæan species, *Sciurus cinereus*, Gmelin, in 1788, took out the southern gray squirrel and gave it the name *Sciurus caro-*

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*It is by no means certain that the northern fox squirrel occurs in the southern Alleghanies.

linensis, thus restricting *Sciurus cinereus* Linn. to the light color phase of the southern fox squirrel, and it becomes a direct synonym of *Sciurus niger* Linn., based on the black phase of the same animal from the same locality.

The only other name that need be considered at all is *Sciurus virginianus* of Kerr's Linnæus, 1792. This name was based on the 'Cat Squirrel' of Pennant's Arctic Zoölogy, which is an indeterminable animal, said to have a very short tail and to inhabit Virginia, where the planters call it 'Cat Squirrel.' As the vernacular name 'Cat Squirrel' is invariably employed in the South for the gray squirrel, it seems likely that the animal in question was nothing more than that species. It may be well to add that Pennant's gray squirrel was a compound animal, including the gray, the southern fox, and perhaps the northern fox squirrels, but referring best to the gray squirrel, as pointed out by Professor Baird in his Mammals of North America in 1857. Professor Baird is the only author to question the standing of Linnæus' *Sciurus cinereus*. With his usual acuteness he saw that the name could not apply to the northern fox squirrel, but for some reason he retained it, probably because Le Conte, Bachman, and others had done so.

Specimens examined.--Total number, 10, from the following localities:

Pennsylvania: Carlisle, 1; Rothruck, 2; — 2.
Maryland: Prince George County, 1; — 1.
West Virginia: White Sulphur Springs, 3.

Sciurus carolinensis carolinensis Gmelin. Southern Gray Squirrel; Cat Squirrel.

1788. *Sciurus carolinensis* Gmelin, Syst. Nat., I, 1788, p. 148 (based on Pennant's Lesser Gray Squirrel from Carolina).
1877. *Sciurus carolinensis* var. *carolinensis* Allen, Monog. N. Am. Sciuridæ, 1877, p. 704.

Type locality.—Carolina.

Geographic distribution.—Austral Zone, from northern Florida north to about the lower Hudson Valley, west through the Alleghanies south of Pennsylvania to Indiana, Missouri, Indian Territory, and the edge of the plains.

Habitat.—In the South, where *Sciurus carolinensis* occurs in the same region with the southern fox squirrel, the two live in woods of very different character. The fox squirrel is exclusively an inhabitant of the flat, open 'piney woods.' The gray squirrel lives in the dense hammocks of live oak and water oak, and in the deep swamps of cypress, black gum, and great magnolia that border the streams. Farther north it is found in the forests and groves of oak, chestnut, and hickory.

Though they feed much on the ground, all the gray squirrels are highly arboreal and very active tree-climbers, springing, when occasion requires it, long distances from branch to branch.

The southern gray squirrel is in many places exceedingly abundant, but is much shot by the negroes for food, and where persecuted is very shy and seldom seen, passing the greater part of the day in hollows or nests in the trees and feeding only in the early morning and after sunset in the evening. It is migratory to a certain extent, its migrations probably depending on the food supply.

General characters.—Size medium; colors quite constant, dark yellowish rusty above, white below; soles of feet usually naked, the heel covered with hair; ears sometimes slightly tufted in winter; pelage soft.

Color.—Upper parts dark yellowish rusty, the hairs annulated black and rusty yellow, with usually some gray-tipped hairs on upper surface of legs and arms, sides of neck, and sides of rump, giving a grayer tone to these parts, the yellowish rusty color predominating on head, middle of back, and along sides; hairs of tail dull yellow at base, then black and tipped with white; under parts white; ears yellowish white, sometimes a slight woolly tuft at base.

Cranial characters.—Skull light, developing with age only slight indications of lateral ridges; rostrum long and rather slender; nasals narrow and short, *not* extending back of ascending branch of premaxilla; zygomata slanting backward from root and lying close to skull (not so much bowed out as in the fox squirrels and not nearly so much so as in the red squirrels); postorbital processes long and slender; penultimate upper premolar normally present in the adult. Size of an average adult skull: basilar length, 50; occipitonasal length, 58.8; zygomatic breadth, 33.2; greatest height of cranium above palate, 19.2; greatest length of single half of mandible, 36.

Size.—Average measurements of two adult specimens from St. Marys, Ga.: total length, 450.5; tail vertebræ, 212; hind foot, 60.8. Average measurements of five adult specimens from Raleigh, N. C.: total length, 461.8; tail vertebræ, 205; hind foot, 63.2.

General remarks.—*Sciurus carolinensis* has escaped synonymy in a most remarkable way. It is rather a happy accident to have the specific name restricted to this form, since it occupies a central position and covers a larger area of country than any one of the four subspecies which surround it and shade directly into it.

The most typical specimens of *S. carolinensis* come from the coast region from northern Florida to Virginia. Specimens from the higher land of North Carolina and Virginia are shading both in color and size toward the northern subspecies (*leucotis*), while those from the lower Mississippi Valley begin to approach the form of the coast of Louisiana (*fuliginosus*). *S. carolinensis typicus* extends about half way down the Florida peninsula before it wholly breaks off into the subtropical form (*extimus*).

Specimens examined.—Total number, 20, from the following localities:

Florida: Rose Bluff, St. Marys River, 1.
Georgia: St. Marys, 4; McIntosh County, 1.
North Carolina: Raleigh, 7; Statesville, 2.
Missouri: Stotesbury, 2.
Indiana: Denver, 1.
Indian Territory: Stilwell, 2.

Sciurus carolinensis leucotis (Gapper). Northern Gray Squirrel.

1830. *Sciurus leucotis* Gapper, Zoöl. Journal, V, p. 206, 1830; Bachman, Proc. Zoöl. Soc. London, 1838, p. 96.
1792. *Sciurus cinereus* Schreber, Säugth., IV, 1792, p. 766, pl. CCXII; Harlan, Fauna Am., 1825, p. 173.
1815. *Sciurus pennsylvanicus* Ord, Guthrie's Geog., 2d Am. ed., II, 1815, p. 292 (*nomen nudum*).
1815. *Sciurus hiemalis* Ord, Guthrie's Geog., 2d Am. ed., II, 1815, p. 292; Rhoads, Appendix to reprint of Ord, 1894, p. 20. (Intermediate.)
1826. *Sciurus niger* Godman, Am. N. H., II, 1826, p. 133; Richardson, Fauna Bor.-Am., I, 1829, p. 191; Bachman, Proc. Zoöl. Soc. London, 1838, p. 96; Aud. and Bach., Quad. N. Am., I, 1849, p. 261, pl. XXXIV.
1842. *Sciurus vulpinus* DeKay, N. Y. Zoöl., I, 1842, p. 59.
1849. *Sciurus migratorius* Aud. and Bach., Quad. N. Am., I, 1849, p. 265, pl. XXXV.
1877. *Sciurus carolinensis* var. *leucotis* Allen, Monog. N. Am. Sciuridæ, 1877, p. 701.
1894. *Sciurus carolinensis pennsylvanicus* Rhoads, Appendix to reprint of Ord, 1894, p. 19.

Type locality.—Region between York and Lake Simcoe, Ontario.

Geographic distribution.—Transition Zone and locally, lower edge of Canadian Zone from the Alleghanies of Pennsylvania north through New York and New England to southern New Brunswick and southern Canada; west to Minnesota.

Habitat.—Hard-wood forests and groves of oak, chestnut, and hickory. Abundant over most of the country it occupies, but local in the north, and only occurring where there are large tracts of hard wood. Often very numerous and tame in the parks of the large cities, where it is carefully protected. The northern gray squirrel is highly migratory, but the migrations probably depend wholly on food supply and occur irregularly. Sometimes a large section of country will be deserted for several years, and at other times an unusually heavy crop of beech nuts or acorns will attract the gray squirrels in enormous numbers.

General characters.—Size large; tail long and bushy; much given to melanism locally, but especially northward. Color of normal examples much lighter above than in *carolinensis typicus*, being silvery gray. Feet large, the soles sometimes covered with hair between the pads in winter.

Color.—In winter pelage, upper parts silvery gray, the hairs banded yellowish brown and black, with long white tips; the yellowish brown color often predominating on head, center of back, and upper surface of hands and feet; under parts white (sometimes a specimen will be a little rusty between fore legs or on neck or chest); hairs of tail long, yellowish at base, then black and deeply tipped with white; ears yellowish white, sometimes with woolly tufts at base. In summer the white tips of the hairs wear off, giving a more yellowish appearance to the whole upper parts, with sometimes a good deal of rusty on the back, sides, neck, and legs. Wholly black (melanistic) individuals are common at some localities, and at such places every degree between the black and gray can be found.

Cranial characters.—Skull larger than that of typical *carolinensis*, but otherwise similar. Size of an average adult skull: basilar length, 54.4;

occipitonasal length, 65.2; zygomatic breadth, 35; greatest height of cranium above palate, 19.8; greatest length of single half of mandible, 37.2.

Size.—Average measurements of five adult specimens from Liberty Hill, Conn.: total length, 505.5; tail vertebræ, 230.6; hind foot, 71.7

General remarks.—Mr. Rhoads, in the appendix to his edition of Ord (1894, p. 19), tries to bring into use Ord's name *Sciurus pennsylvanicus* for the northern gray squirrel, calling it *Sciurus carolinensis pennsylvanicus* (Ord). Ord's name is a *nomen nudum*, and has no standing in nomenclature, even if we can guess the species he meant to apply it to. Gapper's name *leucotis* is well founded and has been in current use for nearly twenty years, ever since Allen reëstablished it in his Monograph of the American Sciuridæ in 1877.

About Ord's *Sciurus hiemalis* I feel some doubt. The name unquestionably was given to a gray squirrel in winter pelage, but from the locality attributed it, "Little Egg Harbor, New Jersey," the animal was probably intermediate between the southern and northern grays, and it therefore seems wiser to allow Gapper's name to stand for the northern gray squirrel.

Specimens examined.—Total number, 33, from the following localities:

Ontario: Mount Forest, 1.
Wisconsin: Madison, 1.
Minnesota: Elk River, 1.
Massachusetts: Belmont, 1; Brookline, 15; Wareham, 4; Marthas Vineyard, 2.
Connecticut: Liberty Hill, 8.

Sciurus carolinensis hypophæus Merriam. Merriam's Gray Squirrel.

1886. *Sciurus carolinensis hypophæus* Merriam, Science, Vol. VIII, p. 351, April 16, 1886; Allen, Bull. Am. Mus. Nat. Hist., Vol. VI, 1894, p. 171, foot-note.

Type locality.—Elk River, Minnesota.

Geographic distribution—The edge of the forest belt in Minnesota (a region having quite a distinctive mammalian fauna). Limits of range unknown.

General characters.—Size large, equaling that of *leucotis.* Color of upper parts rather darker than in *leucotis* and encroaching all round on under parts, leaving only a small central streak of white on belly. Soles of feet densely furred in winter between the pads, naked in summer. Ears well tufted in winter. Pelage in winter very long and full.

Color.—In winter upper parts dark iron gray, mixed with yellowish and rusty; the hairs banded, yellowish rusty and black, and somewhat tipped with white; a small irregular central streak of white on belly; rest of under parts like back; chest and under side of neck sometimes uniform yellowish brown; tail dark, the black band of hairs longer and the white tips shorter than in *leucotis;* ear tufts well developed in winter, yellowish white; in summer the general color is darker and more yellowish, owing to the wearing down of the hair.

Cranial characters.—Skull about the size of that of *leucotis*, showing no characters by which it can be separated from any of the *carolinensis* series. Size of an average adult skull: basilar length, 54.6; occipitonasal length, 63.2; zygomatic breadth, 34.6; greatest height of cranium above palate, 19; greatest length of single half of mandible, 35.4.

Size.—Average measurements of nine adult specimens from Elk River, Minn.: total length, 496.3; tail vertebræ, 220.4; hind foot, 67.2.

General remarks.—Little is known of this fine squirrel. My knowledge of it comes wholly from Dr. Merriam's description and from four specimens from the type locality, Elk River, Minn., kindly lent me by him, and ten topotypes in the Bangs collection.

One point of some interest is that the northern gray squirrel (*Sciurus carolinensis leucotis*) occasionally occurs at Elk River in considerable numbers with *hypophæus*, but has not been known to breed there, appearing only in migrations. This fact suggests the possibility of *hypophæus* proving to be a distinct species when more is known of it.

Specimens examined.—Total number, 14, from Elk River, Minn.

Sciurus carolinensis fuliginosus (Bachman). Bayou Gray Squirrel.

1838. *Sciurus fuliginosus* Bach., Proc. Zoöl. Soc. London, 1838, p. 96; Aud. and Bach., Quad. N. Am., III, 1853, p. 240, pl. CXLIX.
1895. *Sciurus carolinensis fuliginosus* Bangs, Proc. Bost. Soc. Nat. Hist., XXVI, p. 543, 1895; Rhoads, Proc. Acad. Nat. Sciences, Phila., 1896, p. 196.

Type locality.—Near New Orleans, La.

Geographic distribution.—The bayou region of the coast of Louisiana.

General characters.—Size larger than true *carolinensis;* colors rich and dark; under parts never pure white and often clear ferruginous; tail long and bushy, the hairs but slightly tipped with white; feet large, soles naked; ears with often a woolly tuft at base in winter.

Color.—Upper parts deep yellowish ferruginous, varied with black; the hairs banded, many of them having the black band extending to the tip; tail dark, the hairs yellowish ferruginous at base, then black and tipped with white, the black subapical band very broad and the white tips short; under parts varying from clear buffy ferruginous, the chin only gray, to smoky gray; line of demarkation between colors of upper and under parts always low down and irregular; ear tufts well developed, ferruginous in the examples with ferruginous under parts, grayish white in the examples with gray under parts.

Cranial characters.—Skull a little larger than that of true *carolinensis*, otherwise similar. Size of an average adult skull: basilar length, 50.6; occipitonasal length, 60; zygomatic breadth, 33.4; greatest height of cranium above palate, 19.8; greatest length of single half of mandible, 36.

Size.—Average measurements of ten adult specimens from Gibson, La.: total length, 467; tail vertebræ, 219.5; hind foot, 67.

General remarks.—*Sciurus carolinensis fuliginosus* is confined in its extreme form to the heavy swamps of the bayou region of the coast of Louisiana. Farther north in the 'prairie' regions of the same State it begins gradually to approach *carolinensis typicus*, a large series from Acadia Parish, La., showing this tendency. Mr. Rhoads speaks of the living gray squirrels he saw in the park at Memphis, Tenn.,* and refers them to *fuliginosus*, on account of their large size and dark coloring. They are probably about like the examples from central Louisiana, which retain the large size and dark color above, but have pure white under parts, and can safely be called intermediates between *carolinensis* and *fuliginosus*, though perhaps nearer *fuliginosus.*

Specimens examined.—Total number, 37, from the following localities:

Louisiana: Gibson, Terre Bonne Parish, 13; Cartville, Acadia Parish, 3; Point Aux Loups Springs, Acadia Parish, 21. (Those from Acadia Parish not extreme.)

Sciurus carolinensis extimus subsp. nov. Everglade Gray Squirrel.

Type from Miami, Dade Co., Florida. No. 4519, ♀ young adult, collection of E. A. and O. Bangs. Collected March 12, 1895, by L. Brownell. Total length, 432; tail vertebræ, 194; hind foot, 54.

Geographic distribution.—Subtropical fauna of south Florida, northward about half way up the peninsula.

Habitat.—Everglades and oak and cabbage palmetto hammocks. Not found in the 'piney woods.'

General characters.—Size smallest of the *carolinensis* series; tail and hind foot short; color much lighter, more gray than in *carolinensis typicus;* soles naked; ears with sometimes a slight woolly tuft at base.

Color.—Upper parts yellowish gray, the hairs banded black and dull yellow, a few tipped with white (much the same color as the upper parts of *leucotis* in summer pelage); tail light colored, the hairs yellowish at base, then black and tipped with white; under parts white; ear tufts white.

Cranial characters.—Skull smaller than that of true *carolinensis*, otherwise similar. Size of an average adult skull, the type: basilar length, 47; occipitonasal length, 55; zygomatic breadth, 31.2; greatest height of cranium above palate, 18; greatest length of single half of mandible, 33.2.

Size.—Average measurements of seven adult specimens from Miami, Fla.: total length, 438.4; tail vertebræ, 190.9; hind foot, 47.

General remarks.—*Sciurus carolinensis extimus* represents in its small size, short tail, and small hind foot the extreme of differentiation of the *carolinensis* series, but differs widely from true *carolinensis*, its nearest geographical cousin, in its much grayer color. This yellowish gray color is probably highly protective, the animal spending most of its life among trees covered with the gray Spanish moss, *Tillandsia usneoides*, which its color almost exactly matches in tone.

S. carolinensis extimus is only typical in the peculiar subtropical fauna of the everglades and southern part of the Florida peninsula. Specimens from Citrus Co., Fla., are larger and darker in color and are rather nearer to true *carolinensis* than to *extimus*. The gray squirrel of northern Florida is true *carolinensis.*

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* Proc. Acad. Nat. Sciences Phila., 1896, p. 196.

Specimens examined.—Total number, 8, from the following localities: Florida: Miami, Dade Co., 7; Oak Lodge (east peninsula, opposite Micco), Brevard Co., 1; also 21 from Citrus Co. (Citronelle, 2; Blitches Ferry, 19), which are intermediates between *carolinensis* and *extimus.*

Sciurus hudsonicus hudsonicus (Erxleben). Red Squirrel; Chickaree.

1777. *Sciurus vulgaris ε hudsonicus* Erxleben, Mammalia, 1777, p. 416.
1778. *Sciurus hudsonius* Pallas, Nov. Spec. Glir., 1778, p. 376.
1820. *Sciurus rubrolineatus* Desmarest, Mamm., I, 1820, p. 333 (Encyclopédie Méthodique).
1827. *Tamia hudsonia* Lesson, Man. Mamm., 1827, p. 231.
1843. *Tamias rubrolineatus* Schinz, Syn. Mamm., II, 1843, p. 48.
1877. *Sciurus hudsonius* var. *hudsonius* Allen, Monog. N. Am. Sciuridæ, 1877, p. 672.

Type locality.—Hudson Strait. 'Ad fretum Hudsonis.'

Geographic distribution.—Boreal North America, from Labrador to Alaska, south to Maine and the northern peninsula of Michigan, and along the tops of the higher Alleghanies to Roan Mountain, North Carolina.

Habitat.—Spruce and fir forests. Feeds largely on the seeds of conifers.

The northern red squirrel is excessively abundant in all favorable situations. In many places one can often count twenty or thirty individuals within sight or hearing at one time. Always noisy and jerky in its motions, the red squirrel is usually tame and unsuspicious. It feeds and lives both on the ground and in the trees, and is a very agile climber.

General characters.—Size smallest of the eastern squirrels; tail short, flat, and narrow; a decided difference in color and markings between winter and summer pelage;* dorsal stripe in winter chestnut rufous; sides olivaceous gray; white of underparts vermiculated with black; in summer pelage hardly distinguishable from the next subspecies by color alone; soles densely furred in winter and somewhat so in summer; ear tufts in winter, long, protruding well beyond the ear; pelage in winter very full and soft.

Color.—*Winter pelage:* Upper parts with a broad dorsal band extending from between the ears down upper surface of tail, bright chestnut rufous; sides, upper surface of legs and arms, and cheeks olivaceous gray, the hairs banded with black; upper surface of feet and hands often more yellowish; under parts grayish white, thickly vermiculated with blackish, the hairs plumbeous at base. An indistinct blackish line usually shows on sides between colors of upper and under parts. On the upper surface of the tail the hairs are clear chestnut rufous, and only a few have black rings; on the sides and lower surface they are dull yellowish at base and tips and black in the middle. *Summer pelage:* Upper parts with no dorsal stripe; a peculiar ferruginous gray with an olivaceous cast, the hairs banded with black, becoming clear ferruginous on upper surface of hands and feet, and sometimes legs and arms also; under parts white, often

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*In this connection, see Allen on 'Seasonal Variation in Color in *Sciurus hudsonius*,' Bull. Am. Mus. Nat. Hist., Vol. III, p. 41, 1890.

suffused with rusty yellow; a broad black stripe along side separating colors of upper and under parts.

Cranial characters.—Skull light, developing very slight lateral ridges with age; rostrum short and blunt; nasals ending at fronto-premaxillary suture; postorbital process of frontal light and long; zygoma standing out squarely from root, and more flaring than in either the fox or gray squirrels; audital bullæ large. Penultimate upper premolar either absent or present in the adult, though more often absent, and when present very minute.

Size of an average adult skull: basilar length, 38.4; occipitonasal length, 45; zygomatic breadth, 26.2; greatest height of cranium above palate, 15.6; greatest length of single half of mandible, 26.4.

Size.—Average measurements of four adult specimens from Hamilton Inlet, Labrador: total length, 309; tail vertebræ, 120.5; hind foot, 47.75 (all four are very old adults and the averages therefore large). Average measurements of ten adult specimens from Digby, Nova Scotia: total length, 296.5; tail vertebræ, 118.2; hind foot, 45.2

General remarks.—*Sciurus hudsonicus* has but one bad synonym—the *Sciurus rubrolineatus* of Desmarest. Desmarest based his name wholly on the 'Ecureuil rouge (*species nova*)' of the French edition of Warden's Description of the United States, published in 1820. Warden described under this name a red squirrel in winter pelage, assigning it no habitat. It is the only red squirrel Warden gives, and it is impossible to say which race it belonged to. In addition to *Sciurus rubrolineatus* Desmarest gives *Sciurus hudsonius*, his description of the latter being taken from a summer specimen. It is evident that the great difference between summer and winter specimens alone led Desmarest into the belief that there are two species of red squirrels.

Sciurus hudsonicus typicus belongs to the spruce and fir belt and only extends south as far as these trees. Wherever the Transition and Canadian faunas meet, as in central New York, New Hampshire, and Minnesota, intermediates between *hudsonicus typicus* and *hudsonicus loquax* occur. Only a very short distance south, however, into truly Transition country *loquax* is found in the typical form.

Specimens examined.—Total number, 89, from the following localities:

Labrador: Hamilton Inlet, 4.
Nova Scotia: Digby, 16; Granville, 4; James River, 1; Schenacidae (Cape Breton), 6.
New Brunswick: Campobello Island, 9.
Quebec: Lake Edward, 5.
Ontario: North Bay, 8; Nepigon, 1; Peninsula Harbor, 10.
Saskatchewan: Batoche, 5.
Maine: Greenville, 5; Upton, 5.
West Virginia: White Sulphur Springs, 1.
North Carolina: Roan Mountain, 4.

Intermediates:

New Hampshire: Franconia, 2; Antrim, 1.
New York: Peterboro, 1.

Sciurus hudsonicus loquax subsp. nov. Southern Chickaree.

1815. *Sciurus carolinensis* Ord, Guthrie's Geog., 2d Am. ed., II, 1818, p. 292. (Name preoccupied by Gmelin for the southern gray squirrel.)

Type from Liberty Hill, Conn., No. 4270, ♂ adult, collection of E. A. and O. Bangs. Collected by Outram Bangs December 24, 1895. Total length, 323; tail vertebræ, 141; hind foot, 47.

Geographic distribution.—Transition and Carolinian zones, from southern Maine and southern Minnesota to Virginia, west to the edge of the plains. Not found in the tops of the higher Alleghanies where *hudsonicus typicus* takes its place.

Habitat.—Mixed woods, groves, and in fact almost everywhere; perhaps most numerous where there are large tracts of *Pinus rigida*, the seeds of which it is very fond of. Very abundant over the whole of its range except the southern part, where it becomes rare and local.

General characters.—Size somewhat larger than *hudsonicus typicus;* tail longer; color of dorsal stripe in winter pelage usually brighter red; under parts pure grayish white, *not vermiculated;* soles and palms furred in winter, naked in summer.

Color.—*Winter pelage:* upper parts with a broad dorsal band extending from between ears down upper surface of tail, varying from bright ferruginous to orange rufous; sides and upper surface of arms and legs yellow or rusty gray, with sometimes an olivaceous cast, the hairs banded with black; under parts clear grayish white, without vermiculations, the hairs plumbeous at base; usually a black line shows indistinctly along sides between colors of upper and under parts; hairs of upper surface of tail clear ferruginous; those of lower surface and sides dull yellow at base and tip and black in middle. *Summer pelage:* Impossible to tell with certainty from summer pelage of *hudsonicus typicus*, but usually more ferruginous gray and less olivaceous gray.

Cranial characters.—Skull averaging larger than that of *hudsonicus typicus;* otherwise similar. Size of an average adult skull (the type): basilar length, 40; occipitonasal length, 46.4; zygomatic breadth, 27; greatest height of cranium above palate, 16.4; greatest length of single half of mandible, 28.

Size.—Average measurements of eight adult specimens from Liberty Hill, Conn.: total length, 318.3; tail vertebræ, 133.5; hind foot, 47.42.

General remarks.—Professor Baird, in his Mammals of North America, first pointed out the fact that northern examples of *Sciurus hudsonicus* had the under parts vermiculated with black and the southern examples did not. Dr. Allen, in his Monograph of the North American Sciuridæ, dwelt at some length on the differences between the two races, but did not separate them by name. In winter pelage *Sciurus hudsonicus typicus* and *Sciurus hudsonicus loquax* can be told apart at a glance, but in their summer coats they are not so easily distinguished; as a rule, however, *loquax* is more rusty and less olivaceous, and the difference in size between individuals of the same age is well marked, *hudsonicus typicus* being always the smaller of the two.

Specimens examined.—Total number, 56, from the following localities:
Connecticut: Liberty Hill, 11.
Massachusetts: Wareham, 24; Wayland, 1; Brookline, 1.
Indiana: Denver, 14.
Minnesota: Steel Co., 1.
Wisconsin: Waupaca, 2.
North Carolina: Magnetic City, foot of Roan Mountain, 2 (not quite typical).

Genus SCIUROPTERUS F. Cuvier.

Tail flat, laterally expanded, densely haired with fine hairs; an expansion of the skin of the sides extends from wrist to ankle, and when spread acts, with the flat tail, like a parachute, enabling the animal to make long, slanting descents through the air; pelage very fine and dense; skull light; audital bullæ large; end of the pterygoid process resting against audital bulla; rostrum short; occipital region slightly drooping and turned under; interorbital constriction deep and zygoma drooping to make room for the large eye; penultimate upper premolar always present; nocturnal animals.

Sciuropterus sabrinus (Shaw). Severn River Flying Squirrel.

1801. *Sciurus sabrinus* Shaw, Gen. Zoöl., I, 1801, p. 157.
1778. "*Sciuro volante majore*" Pallas, Nova Spec. Glires, 1778, p. 354 (not a scientific name).
1788. *Sciurus hudsonius* Gmelin, Syst. Nat., I, 1788, p. 153 (preoccupied).
1815. *Sciurus labradorius* Ord, Guthrie's Geog., 2d Am. ed., 1815, p. 292 (*nomen nudum*).
1828. *Pteromys sabrinus* Richardson, Zoöl. Journ., III, 1828, p. 519; Aud. and Bach., Quad. North Am., III, 1853, p. 202.
1829. *Pteromys hudsonius* Fischer, Syn. Mamm., 1829, p. 365; Baird, Mamm. North Am., 1857, p. 288.
1874. *Sciuropterus volucella* var. *hudsonius* Allen, Proc. Boston Soc. Nat. Hist., XVI, 1874, p. 289; Monog. N. Am. Sciuridæ, 1877, p. 655.

Type locality.—Severn River, James Bay, Canada.

Geographic distribution.—Boreal North America, south in the east to northern New York and southern New Hampshire.

Habitat.—Mixed woods and forest; nocturnal, spending the day in hollows and nests in the trees.

General characters.—Size, largest of the eastern flying squirrels; tail broad, the hairs long; hind foot large; a decided difference in color between winter and summer pelage; under side of tail washed with sooty; hairs of under parts, plumbeous at base, showing through, and giving a decidedly gray appearance to under parts; soles furred both in winter and summer, only the pads naked.

Color.—*Winter pelage:* upper parts very glossy, wood brown to cinnamon, often somewhat shaded with yellow, darkening on tail towards tip to sooty; hairs of back and sides dark plumbeous below, the merest tip being colored, the plumbeous color therefore showing through whenever the fur is the least disturbed; upper surface of feet and hands sooty gray;

cheeks gray; a black orbital ring; ears sparsely haired, dusky; under parts dirty white, the hairs plumbeous at base; under side of tail yellowish white washed with drab and sooty. *Summer pelage:* whole upper parts uniform sooty drab.

Cranial characters.—Skull large; audital bullæ small and flat (for the genus); the bone dense; nasals slightly turned up at end—pug-nosed; all the teeth, including penultimate upper premolar, large. Size of an average adult skull: basilar length, 32.4; occipitonasal length, 38.4; zygomatic breadth, 22.8; greatest height of cranium above palate, 12.4; greatest length of single half of mandible, 23.4.

Size.—Average measurements of seven adult specimens from Greenville, Maine: total length, 278.6; tail vertebræ, 130.4; hind foot, 37.6.

General remarks.—Dr. Allen, in 1874, relegated this fine species to subspecific rank, calling it a variety of *Sciuropterus volans* (alias *volucella*), and followed the same arrangement in 1877 in his Monograph of the Sciuridæ, where he makes the statement "Grades insensibly into var. *volucella.*" How or where Dr. Allen found intergrades I am at a loss to know. In reality *Sciuropterus sabrinus* and *S. volans* are two distinct species and never intergrade. Wherever their geographic ranges meet they occur together, often in the same wood, each species keeping distinct and retaining its characters as well as where far removed from contact with the other. *S. sabrinus* meets and overlaps the range of *S. volans* for a short distance, wherever the Canadian and Transition faunas meet. Dr. C. Hart Merriam found both species breeding in the Adirondack region of New York, and in his interesting accounts of the habits of these squirrels clearly shows the two to be specifically distinct, although he retained the varietal names of Allen. In the same wood lot at Peterboro, N. Y., Mr. Gerrit S. Miller, Jr., took on November 22, 1894, a fine example of *S. volans*, and on December 28, 1895, a pair of *S. sabrinus*. He has kindly lent me the specimens, which are now before me. I have both species from Hancock, N. H., but there *volans* is apparently the more common. I have yet to see a specimen that is in any way intermediate between *S. sabrinus* and *S. volans*, and if one did turn up it would be safe to consider it a natural hybrid and not an intergrade.

Specimens examined.—Total number, 24, from the following localities:

Nova Scotia: Annapolis, 3; Digby, 1.
Ontario: Nepigon, 1.
Maine: Greenville, 8; Bucksport, 2.
New Hampshire: Hancock, 1.
New York: Peterboro, 2.
Arctic America: Red River, 2; Fort Resolution, 1; Big Island, 1; Moose Factory, 2.

Sciuropterus silus sp. nov. Alleghany Mountain Flying Squirrel.

Type from top of Katis Mountain, White Sulphur Springs, W. Va., at an altitude of 3,200 feet. No. 4931, ♂ adult, collection of E. A. and O. Bangs. Collected by Thaddeus Surber September 2, 1895. Total length, 214; tail vertebræ, 92; hind foot, 28.

Geographic distribution.—Limits of range unknown, probably the higher southern Alleghanies.

General characters.—Size smallest of the eastern flying squirrels; similar in general appearance to *S. sabrinus*, but darker in color; soles naked in summer.

Color.—The type (in summer, beginning to change to winter pelage): upper parts hair brown, shading in places toward isabella color; ears and upper surface of tail, feet, and hands sooty; cheeks dark gray; a black orbital ring; under parts grayish white, the hairs somewhat darker at base; under surface of tail drab, shading to sooty; soles and palms naked; the skin black.

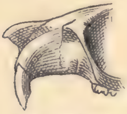

FIG. 29.—Rostrum of *Sciuropterus silus.*

Cranial characters.—Skull very small, similar to that of *S. sabrinus* in respect to the flat audital bullæ and large teeth, but differing in having the foramen ovale transversely oval instead of round. The peculiar pug-nosed effect given by the turned-up ends of the nasals is even more exaggerated than in *sabrinus.* Size of the type skull: basilar length, 25.8; occipitonasal length, 31; zygomatic breadth, 19; greatest height of cranium above palate, 12.2; greatest length of single half of mandible, 18.6.

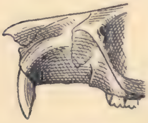

FIG. 30.—Rostrum of *Sciuropterus volans.*

Size.—The type: total length, 214; tail vertebræ, 92; hind foot, 28.

General remarks.—*Sciuropterus silus* is known at present only by the type, all my efforts to get additional specimens having so far failed. Lieut. Wirt Robinson spent part of the summer of 1896 at White Sulphur Springs, W. Va., and kindly offered to get me flying squirrels. He succeeded in taking but one, a perfectly typical example of *S. volans.* It was taken at an altitude of about 1,200 feet lower than the type of *S. silus.* It is probable that the ranges of the two species overlap.

Sciuropterus silus bears no very close relationship to *S. volans*, although it is even smaller than that species. Its affinities lie with *S. sabrinus*, of which it is probably the Alleghany Mountain representative. It is, however, so very much smaller than that species and differs from it so much in other respects that I have accorded it specific rank.

Specimen examined.—The type.

Sciuropterus volans volans (Linn.). Southern Flying Squirrel.

1758. *Mus volans* Linn., Syst. Nat., ed. 10, I, 1758, p. 63.
1758. *Sciurus volans* Linn., Syst. Nat., ed. 10, I, 1758, p. 64 (in part).
1788. *Sciurus volucella* Pallas, Nov. Spec. Glires, 1788, p. 351.
1818. *Pteromys volucella* Desmarest, Nouv. Dict. d'Hist. Nat., XXVII, 1818, p. 406; Aud. and Bach., Quad. N. Am., I, 1849, p. 216, pl. XXVIII; Baird, Mamm. N. Am., 1857, p. 286.
1828. *Sciuropterus volucella* Geoffroy, Dict. Class. d'Hist. Nat., XIV, 1828, p. 132.
1874. *Sciuropterus volucella* var. *volucella* Allen, Proc. Boston Soc. Nat. Hist., XVI, 1874, p. 189; Monog. N. Am. Sciuridæ, 1877, p. 655.
1890. *Sciuropterus volans* Jordan, Man. Vertebrates, 1890, p. 324, footnote.

Type locality.—North America (Virginia ?).*

Geographic distribution.—Transition and Carolinian zones of the east; from northern New York and southern New Hampshire south to Georgia; west to the plains.

Habitat.—Forests and groves; everywhere abundant, nocturnal, spending the day in hollow trees or nests made of bark, leaves, and moss.

General characters.—Size medium, considerably smaller than *S. sabrinus;* hind foot smaller; tail narrower and of a rather different shape, tapering off more toward the end; no decided difference in color between winter and summer pelage; hairs of under parts white to the base; soles furred in winter, only the pads naked; wholly naked in summer; palms naked throughout the year.

Color.—*Winter pelage:* upper parts drab, often shaded irregularly with russet, slightly darker on upper surface of tail, the hairs plumbeous below, only the tips being colored; upper surface of hands grayish white; upper surface of feet drab, the toes and inner edge grayish white; cheeks grayish white; a black orbital ring; ears nearly naked, the skin dusky; under parts pure white, usually washed on lower surface of tail and sometimes of legs and flying membrane with pinkish buff, the hairs white basally. *Summer pelage* not differing materially from the winter, the upper parts usually more russet, having the appearance of being due to fading and wearing rather than to a change in color; the white of under parts often soiled, and the color of under surface of tail more intense.

Cranial characters.—Skull smaller and lighter than that of *S. sabrinus,* audital bullæ larger, not flattened, the bone light and papery; nasals not so much turned up at ends; teeth, including penultimate upper premolar, lighter throughout. Size of an average adult skull: basilar length, 28.8; occipitonasal length, 34.2; zygomatic breadth, 21; greatest height of cranium above palate, 12.2; greatest length of single half of mandible, 20.6.

Size.—Average measurements of seven adult specimens from Liberty Hill, Conn.: total length, 234.5; tail vertebræ, 99.6; hind foot, 31.4.

General remarks.—*Sciuropterus volans* retains its characters, with only a slight range of individual variation, throughout the whole of the Transition and Carolinian zones, but in the lower Austral Zone begins to approach the slightly different form of peninsular Florida. A series from St. Marys, Ga., is intermediate both in cranial characters and color between *S. volans typicus* and *S. volans querceti.* In the north *S. volans* overlaps the range of *S. sabrinus* for a short distance, the two meeting wherever the Transition and Canadian faunas run into each other.

Specimens examined.—Total number, 28, from the following localities:

New Hampshire: Hancock, 3.
New York: Peterboro, 1.

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* No definite type locality can be assigned the southern flying squirrel. Linnæus based his *Mus volans* on Ray, Edwards and Seba, and himself gives Virginia and Mexico as its habitat.

Ray tells us "In Nova Hispania atque etiam Virginia reperitur."

Seba does not specify where his specimen came from, though he calls it *Sciurus volans virginianus.*

Edwards says: "They are brought to us from several parts of North America and have been of late discovered in Poland."

Massachusetts: Wareham, 4; Mount Greylock, 1; Waverly, 3; Concord, 1; Waltham, 1.
Connecticut: Liberty Hill, 8.
Indiana: Denver, 1.
Missouri: Stotesbury, 1.
Maryland: Forest Glen, 1.
Virginia: Nelson County, 2.
West Virginia: White Sulphur Springs, 1.

Intermediates:
Georgia: St. Marys, 10; McIntosh County, 1.

Sciuropterus volans querceti subsp. nov. Florida Flying Squirrel.

Type from Citronelle, Citrus Co., Fla., No. 2451, ♀ old adult, collection of E. A. and O. Bangs. Collected by F. L. Small, September 17, 1894. Total length, 235; tail vertebræ, 95; hind foot, 32.

Geographic distribution.—Peninsular Florida, north to southern Georgia; exact western limits of range unknown.

Habitat.—The hammocks and margins, where there is plenty of live oak and water oak; nocturnal, spending the day in hollow stumps or in nests in the thick bunches of Spanish moss.

General characters.—Very similar to *S. volans typicus*, from which it differs in having the upper parts more uniform russet, and the under parts, especially the under surface of tail, strongly washed with the same color; soles naked; audital bullæ wheel-shaped, very large and deep.

Color.—Upper parts russet, shading to yellowish drab in places; cheeks grayish white; upper surface of feet and hands sooty gray; toes rather lighter; under parts white, a good deal shaded with pinkish russet.

Cranial characters.—Skull similar to that of *S. volans*, except that the audital bullæ are much larger, more inflated, and broadly wheel-shaped (see figs. 31 and 32). Size of an average adult skull (the type): basilar length, 30.2; occipitonasal length, 34.6; zygomatic breadth, 21; greatest height of cranium above palate, 12.8; greatest length of single half of mandible, 21.4.

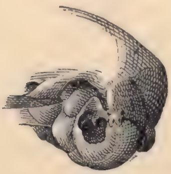


FIG. 31.—Audital bulla of *Sciuropterus volans.*

Size.—Average measurements of three adult specimens from Citronelle, Fla.: total length, 237.66; tail vertebræ, 102.66; hind foot, 31.33.

General remarks.—*Sciuropterus volans querceti* passes into true *volans* in southern Georgia, a series of specimens from St. Marys, Ga., being intermediate between the two. A specimen from Powhatan Plantation, near Gibson, La., without a skull, seems referable to this form, and may thus extend its range tc the coast of Louisiana.

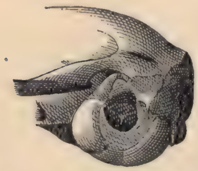


FIG. 32.—Audital bulla of *Sciuropterus v. querceti.*

Specimens examined.—Total number, 3, all from Citronelle, Citrus Co., Fla.

EXPLANATION OF PLATES.

All the figures are life size and were drawn by Dr. J. C. McConnell.

PLATE VIII.

Fig. 1. *Sciurus niger* L.—♀ old adult, Citronelle, Fla. (No. 1978, Bangs coll.)

2. *Sciurus ludovicianus* Custis—♂ old adult, Point aux Loups Springs, La. (No. 2929, Bangs coll.)

3. *Sciurus ludovicianus vicinus* Bangs—♀ old adult; the type, White Sulphur Springs, W. Va. (No. 5215, Bangs coll.)

4. *Sciurus carolinensis hypophæus* Merriam—♂ old adult, Elk River, Minn. (No. 3942, Merriam coll.)

PLATE IX.

Fig. 1. *Sciurus carolinensis leucotis* Gapper—♀ old adult, Liberty Hill, Conn. (No. 1043, Bangs coll.)

2. *Sciurus carolinensis fuliginosus* (Bach.)—♂ old adult, Gibson, La. (No. 2833, Bangs coll.)

3. *Sciurus carolinensis* Gmelin—♀ old adult, St. Marys, Ga. (No. 5141, Bangs coll.)

4. *Sciurus carolinensis extimus* Bangs—♀ adult; the type, Miami, Fla. (No. 4519, Bangs coll.)

PLATE X.

Fig. 1. *Sciurus hudsonicus loquax* Bangs—♂ old adult; the type, Liberty Hill, Conn. (No. 4270, Bangs coll.)

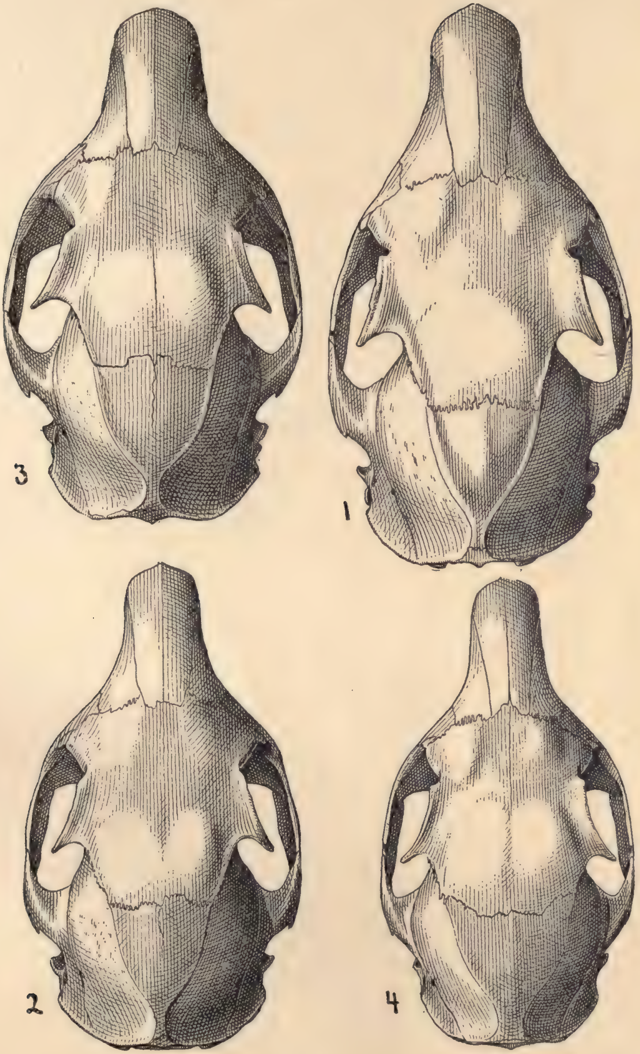
2. *Sciurus hudsonicus* (Erxleben)—♂ old adult, Hamilton Inlet, Labrador. (No. 3956, Bangs coll.)

3. *Sciuropterus sabrinus* (Shaw)—♂ old adult, Greenville, Me. (No. 4962, Bangs coll.)

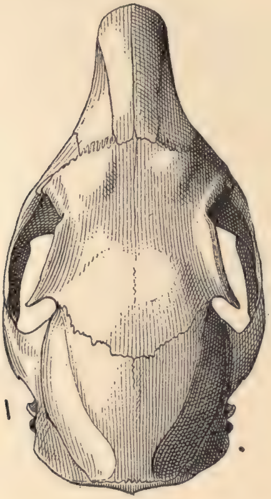
4. *Sciuropterus volans querceti* Bangs—♀ old adult; the type, Citronelle, Fla. (No. 2451, Bangs coll.)

5. *Sciuropterus volans* (L.)—♂ old adult, Liberty Hill, Conn. (No. 4269, Bangs coll.)

6. *Sciuropterus silus* Bangs—♂ adult; the type, top of Katis Mountain, White Sulphur Springs, W. Va. (No. 4931, Bangs coll.)



1 Sciurus niger
2 Sciurus ludovicianus
3 Sciurus ludovicianus vicinus
4 Sciurus carolinensis hypophæus



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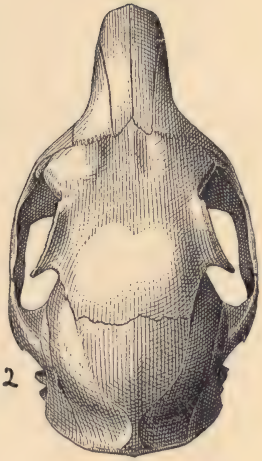

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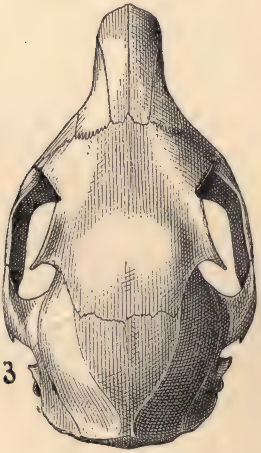

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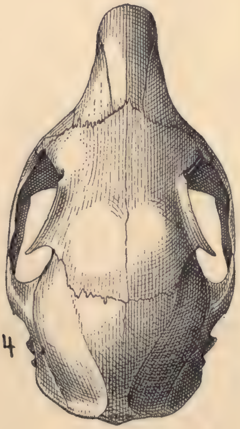

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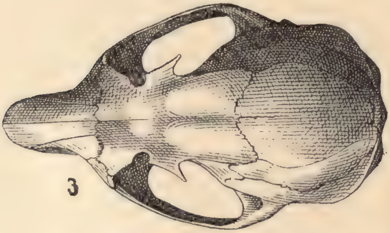
1 Sciurus carolinensis leucotis
2 Sciurus carolinensis fuliginosus
3 Sciurus carolinensis
4 Sciurus carolinensis extimus



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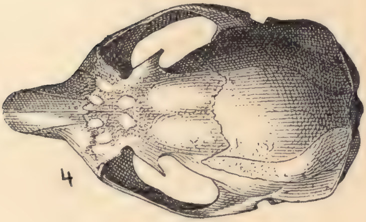

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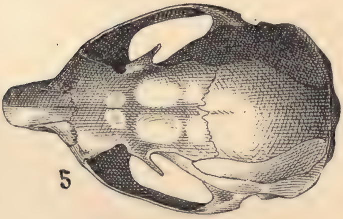

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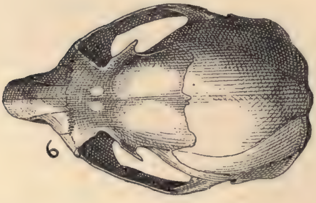

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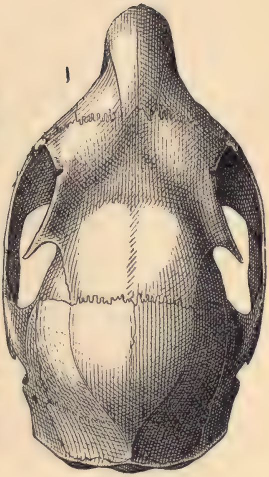

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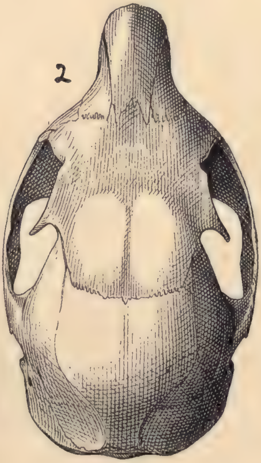

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1 SCIURUS HUDSONICUS LOQUAX
2 SCIURUS HUDSONICUS
3 SCIUROPTERUS SABRINUS
4 SCIUROPTERUS VOLANS QUERCETI
5 SCIUROPTERUS VOLANS
6 SCIUROPTERUS SILUS

Vol. X, pp. 169-174 December 29, 1896

PROCEEDINGS

OF THE

BIOLOGICAL SOCIETY OF WASHINGTON

ROMEROLAGUS NELSONI, A NEW GENUS AND SPECIES OF RABBIT FROM MT. POPOCATEPETL, MEXICO.

BY DR. C. HART MERRIAM.

Among the many new and interesting mammals collected by Mr. E. W. Nelson in Mexico during the past five years, one of the most remarkable is a small, short-eared, tailless rabbit discovered high up on Mt. Popocatepetl, at and above an altitude of 3,000 meters (approximately 10,000 feet). This singular animal has exceedingly short hind legs, and instead of moving by a series of leaps like ordinary rabbits, runs along on all fours, and lives in runways in the grass like the meadow mice.

Mr. Nelson has prepared, at my request, the following account of his experience with this extraordinary animal. He says: "On my first visit to Mt. Popocatepetl in the spring of 1893, I learned that these little rabbits were found there, and on my return to the city of Mexico I prepared for an expedition to secure them. On January 5, 1894, my assistant, Mr. E. A. Goldman, and I made our camp on the side of a cañon at an altitude of about 3,350 meters (11,000 feet) on the northwest slope of the mountain. We were accompanied by three Indian hunters and our packer. Among the firs and alders at this altitude the northerly slopes of the hills and cañons are covered with a luxuriant growth of saccaton grass in huge bunches, from three to six feet across, and often reaching a height of 6 or 8 feet, which covers the ground so that the only open spaces are small spots scattered irregularly here and there. A search under the overhanging masses of long grass blades showed a perfect network of large arvicola-like runways tunneling through the bases of the tussocks, and passing from one to another under the shelter of the outcurving masses of leaves. It was evident that the rabbits were very numerous here, and we all proceeded to hunt the vicinity carefully for them. The first day I saw three, but was unable to get a shot at any. One came running through the grass along one of the hidden trails and, seeing me, stopped in a little opening only seven or eight feet away. It was too near to shoot, and so escaped after looking at me with inquiring eyes for a few moments. The next evening I shot one by taking a stand on a large log, whence I could see several small openings in the grass, and saw one as it stopped a moment at the entrance of a runway. By persistent hunting for three days my Indians secured three more.

"On our first night wire snares were set without success, so the next night we put out a lot of steel traps in the runways. This latter method was very successful, and three fine specimens were taken in a small area a few yards across. So far as observed, these animals are strictly limited to the heavy growth of saccaton grass, between about 3,050 and 3,650 meters (10,000 and 12,000 feet), a few ranging a little above and below these limits in favorable places along cañon slopes. I found them equally numerous in the heavy grass on cañon slopes and hillsides and in the dense growth of grass about the sides of the small park-like openings in the forest. They make their forms within the matted bases of the huge grass tussocks by tunneling passageways along the surface of the ground through the mass of old grass leaves and stems and then hollowing out snug retreats within the weather-proof shelters thus obtained. Their concealed runways were intermingled with those of the common meadow mice of the mountains, and the striking resemblance in coloration and habits between the two animals was remarkable. Like the arvicolas, the rabbits are mainly nocturnal, but are occasionally found moving about by day. They become more active just at dusk, and on frosty mornings sometimes come out at sunrise into the small openings among the grass to bask in the warmth. My Indian hunters claimed that they often found them out sunning themselves in this way on summer afternoons after cold, heavy showers.

"This species has practically no external tail, though in some specimens there is a small fleshy papilla two or three millimeters in length; in others even this is absent. In this respect the animal resembles the pikas (*Lagomys*)."

Animals differing so widely in habits and manner of progression as the present species and the ordinary rabbits would be expected to differ in their skeletons. Fortunately, Mr. Nelson preserved a perfect skeleton of the new rabbit, which on comparison with those of the several subgenera of *Lepus* shows differences of considerable morphologic weight.

The clavicle is complete and articulates directly with the sternum (fig. 33)—a thing that never happens in the genus *Lepus*. Huxley describes the clavicle of the rabbit as "incomplete at both ends," and Flower states that it "is very short and is suspended by long ligaments between the scapula and the sternum." The manubrium or presternum is broadly expanded between and anterior to the articulation of the first pair of ribs (fig. 33), a condition unknown in the genus *Lepus*, in which it is always long and narrow (fig. 34). Flower calls attention to the correlation existing between the form of the presternum and the degree of development of the clavicle, stating that "the presternum is compressed and produced forwards in those rodents in which the clavicle is absent or rudimentary," as the hares, and "is generally broad in the forms which have the clavicle well developed, as the rats, beavers, &c." This interesting correlation is well exemplified in the Popocatepetl rabbit, which, having a complete clavicle, has also a broad manubrium. The segments of the mesosternum (between the presternum and xiphoid) are only three in number (fig 33), while in all the subgenera of *Lepus* the number is four (fig. 34). The ribs are correspondingly reduced, only six pairs instead of seven articulating with the sternum. The tubercles of the ribs are not produced into spiniform processes, as in *Lepus*, and disappear in the sixth pair. In *Lepus* they extend to the eighth pair. The scapula is rather narrow, with a long metacromial process, as in *Lepus*. There are four sacral vertebræ, as in *Lepus* (the first and anterior part of the second articulating with the ilia), and nine

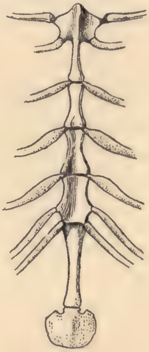

FIG. 33—Sternum of *Romerolagus nelsoni* (nat. size).

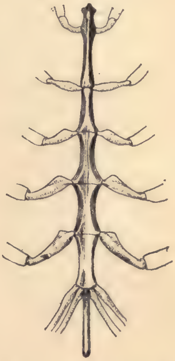

FIG. 34—Sternum of *Lepus timidus* (much reduced).

caudal vertebræ, the last three of which are upturned and rudimentary.

The fifth cervical vertebra is peculiar. Its transverse process projects directly outward instead of backward, and its inferior lamella has only a trace of the posterior extension usual in rabbits. The metapophyses begin on the tenth dorsal vertebra and are present in all the succeeding vertebræ to the last lumbar, inclusive. The anapophyses are much as in *Lepus* proper, being present, though small, on the ninth to twelfth dorsals, inclusive, and on all the lumbar vertebræ except the sixth and seventh. The transverse processes of the lumbar vertebræ are peculiar, each developing a broad posterior flange, which extends the full length of the side of the vertebra. Hypopophyses are present on the first, second, and third lumbar vertebræ, as in *Lepus*, though relatively short.

The bones of the legs and feet show a number of more or less important differences, some of which may be mentioned here. The depression on the inner side of the trochlear facet of the humerus is small and flat instead of deeply sulcate; the fibular malleolus is less strongly developed; the navicular bone differs materially in form and its inferior crest is conspicuously shorter than in *Lepus*, and does not reach forward beneath the bases of the metatarsals.

The skull, singularly enough, does not show the departure from *Lepus* that one would expect from a study of the other bones. It agrees in the main with skulls of the American cottontails (subgenus *Sylvilagus*), but differs in the postorbital processes, which are small, divergent posteriorly, and altogether wanting anteriorly, and in the jugal, which is greatly elongated posteriorly. The interparietal is distinct, and in old age becomes ankylosed with the supraoccipital. The thoroughly leporine character of the skull shows that the animal can hardly be regarded as ancestral to *Lepus*, as might have been inferred from its short ears, short hind legs, and various skeletal characters, but that it is a specialized offshoot from the genus *Lepus* itself.

The taxonomic value of the characters which serve to distinguish the Popocatepetl rabbit from the true rabbits, and more particularly the peculiarities of its sternum and clavicle, require the erection of an independent genus for its reception. Heretofore the genus *Lepus* has enjoyed the distinction of coincidence in characters with the family to which it belongs. Now the family circle of the Leporidæ must be extended to include the new member.*

From the foregoing it will be evident that the new animal is of unusual interest to naturalists. The curious combination of its anatomical characters, the peculiarity of its mode of locomotion, the oddity of its habits, and the isolation of its home—high up on lofty Popocatepetl—give it an interest quite apart from that which attaches to most new discoveries. For this reason it affords me special pleasure to bestow upon the new and remarkable genus, of which it is the type, the name *Romerolagus*, in honor of the venerable Señor Don Matias Romero, Envoy Extraordinary and Minister Plenipotentiary from Mexico, as a slight token of appreciation for the active interest he has taken in the explorations of the United States Biological Survey in Mexico, and in recognition of the many courtesies he has extended to our field naturalists during the past five years.

ROMEROLAGUS gen. nov.

Type.—Romerolagus nelsoni sp. nov., from Mt. Popocatepetl, Mexico.

Diagnosis.—Size small; ears exceedingly short, shorter than in any known species of *Lepus;* hind legs and feet short; skull much as in *Lepus* (subgenus *Sylvilagus*), except that the postorbital processes are small, divergent, and wanting anteriorly, and the jugals much elongated posteriorly; clavicle complete and articulating with both sternum and scapula; presternum broadly expanded anteriorly, much broader than long in front of first pair of ribs [narrow and slender in *Lepus*]; mesosternum of 3 segments [4 in *Lepus*]; 6 pairs of ribs articulating with sternum [7 pairs in *Lepus*]; transverse process of 5th cervical vertebra directed straight outward (instead of backward), its inferior lamella lacking the usual posterior extension; transverse processes of all lumbar vertebræ broadly expanded, their bases covering entire length of vertebræ; hypopophyses present on first 3 lumbar vertebræ, but small; inferior crest of navicular bone short and not produced under base of metatarsal.

Romerolagus nelsoni sp. nov. Popocatepetl Rabbit.

Type from Mt. Popocatepetl, Mexico (altitude 3,350 meters or 11,000 feet). No. 57949, ♂ ad., U. S. Nat. Mus., Dept. Agric. coll. Collected Jan. 6, 1894, by E. W. Nelson and E. A. Goldman. Original number 5639.

Geographic distribution.—Boreal Zone of Mt. Popocatepetl, between the altitudes of 3,050 and 3,660 meters (10,000–12,000 feet).

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* It is singular that of the four characters given by Flower and Lydekker in the first sentence of their diagnosis of the family Leporidæ ("imperfect clavicles, elongated hind limbs, short recurved tail, and long ears"), not one applies to the Popocatepetl rabbit.

General characters.—Size small; ears and hind feet very short; no external tail; coloration dark.

Color.—Upper parts, sides, and pectoral collar grizzled grayish brown, with a yellowish suffusion, and strongly mixed with black-tipped hairs (the yellowish due to a broad subapical zone of this color on each hair); belly and chin smoky grayish washed with buffy; upper surfaces of feet buffy yellowish, much lighter than rest of upper parts; ears without markings.

Cranial characters.—Skull similar in a general way to that of *Lepus sylvaticus*, but much smaller; supraorbital processes small, slender, divergent, and not approaching frontals posteriorly; jugals much elongated and incurved posteriorly, not defined anteriorly (supraorbital notch absent); braincase less decurved and more depressed posteriorly than in *Lepus sylvaticus* and its allies; zygomata standing far out from sides of cranium; palatal bridge relatively broad; audital bullæ moderately inflated.

Measurements.—Type specimen: total length, 311; tail vertebræ, 0; hind foot, 53; ear from notch in dry skin, 36. Average of 6 adults from type locality: total length, 295; hind foot, 52. The type is the largest of the seven specimens.

Remarks.—Mr. Nelson's account of the habits of this rabbit, as observed by him on Mt. Popocatepetl, has been given at the beginning of the present article. Mr. Nelson saw runways which he believes were those of the same species, at an altitude of 3,050 to 3,350 meters (10,000 te 11,000 feet) on the southeast side of Mt. Iztaccihuatl.

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